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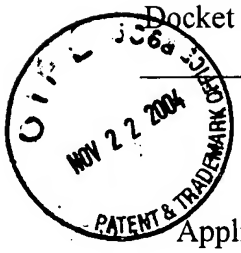
Docket No.: FY.51040US1A **Customer No.: 20,995**



AMENDMENT / RESPONSE TRANSMITTAL

Applicant	:	Nash et al.
App. No.	:	10/796,692
Filed	:	March 9, 2004
For	:	OFF-ROAD VEHICLE WITH WHEEL SUSPENSION
Examiner	:	Unknown
Art Unit	:	3618

CERTIFICATE OF MAILING

I hereby certify that this correspondence and all marked attachments are being deposited with the United States Postal Service as first-class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on

November 17, 2004
(Date)

William H. Shreve, Reg. No. 35,678

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Transmitted herewith for filing in the above-identified application are the following enclosures:

(X) English translations of U.S. Provisional Application No. 60/459,957 (33 pages) and 60/459,959 (35 pages) filed April 2, 2003 .

(X) Two Verifications of Translation.

(X) Return prepaid postcard.

(X) Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

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VERIFICATION OF TRANSLATION

I, undersigned below, hereby declare that:

My name and post office address are as stated below:

That I am knowledgeable in the English language and in the language in which the below identified U.S. Provisional Application was filed, and that I believe the attached English translation of the U.S. Provisional Application No. 60/459,959 filed on April 2, 2003 is a true and complete translation of the above-identified Provisional Application as filed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 10/8/2004

Full Name of the Translator: Yasuhiro Tochigi

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[Document Name] Specification

[Title of the Invention] REAR WHEEL SUSPENSION DEVICE FOR ALL-TERRAIN VEHICLE

[Claims]

[Claim 1] A rear wheel suspension device for an all-terrain vehicle having wheels for running on the rough ground arranged at respective right and left sides of front and rear portions of a body frame, comprising rear suspension arms supported by right and left parts of the front portion of the body frame for vertical swinging movement for supporting the rear wheels, wherein the rear portion of the body frame is constituted of upper and lower frames extending in the longitudinal direction of the vehicle and front and rear vertical frames extending vertically and connecting the upper and lower frames, and front and rear pivot parts of the rear suspension arms are rotatably supported by the front and rear vertical frames.

[Claim 2] The rear wheel suspension device for an all-terrain vehicle according to Claim 1, wherein the upper and lower frames are offset from each other to the outside and inside, respectively, in the transverse direction of the vehicle, and the front and rear vertical frames are inclined such that the upper parts of the front and rear vertical frames are located further outside than the lower parts thereof and connect the upper and lower frames.

[Claim 3] The rear wheel suspension device for an all-terrain vehicle according to Claim 1 or 2, wherein each of the front and rear vertical frames is constituted of a pair of side walls and a bottom wall integrally joining the side walls and has a generally U-shaped transverse cross-section with the open side facing outside in the transverse direction of the vehicle, and the pivot parts of the rear suspension arms are located within the U-shape of the front and rear vertical frames and pivoted on support

pins extending through the side walls.

[Claim 4] The rear wheel suspension device for an all-terrain vehicle according to any one of Claims 1 to 3, wherein the rear wheel suspension device is a double wishbone type wheel suspension device, and all the four pivot parts of the upper and lower suspension arms are rotatably supported by the front and rear vertical frames.

[Detailed Description of the Invention]

[Field of the Invention]

This invention relates to a rear wheel suspension device for an all-terrain vehicle.

[Prior Art]

An all-terrain vehicle of this type needs to have a body frame which is right in weight and has high rigidity from the viewpoint of its use. Thus, the body of such an all-terrain vehicle is usually formed by a steel pipe frame (for example, see Patent Document 1). Also, the rear suspension arms for supporting the rear wheels for vertical swinging movement have pivot parts which are rotatably supported by brackets joined by welding directly to the pipe frame.

[Patent Document 1]

JP-Y-Hei 06-34213

[Problem to be Solved by the Invention]

When the rear suspension arms are rotatably supported by brackets joined by welding to the pipe frame, there is a problem that the degree of freedom in the mounting positions of the brackets on the pipe frame is low. Also, there is a problem that the required strength cannot be achieved depending on the mounting positions of the brackets. As a result, the basic structure of the body frame must be changed depending on the positions where the rear suspension arms should be pivoted.

This invention has been made to solve the above problem. It is therefore an object of the invention to provide a rear

wheel suspension device for an all-terrain vehicle in which the degree of freedom in the mounting positions of the rear suspension arms is enhanced without changing the basic structure of the body frame.

[Means for Solving the Problem]

The invention of Claim 1 is characterized by a rear wheel suspension device for an all-terrain vehicle having wheels for running on the rough ground arranged at respective right and left sides of front and rear portions of a body frame, comprising rear suspension arms supported by right and left parts of the front portion of the body frame for vertical swinging movement for supporting the rear wheels, in which the rear portion of the body frame is constituted of upper and lower frames extending in the longitudinal direction of the vehicle and front and rear vertical frames extending vertically and connecting the upper and lower frames, and front and rear pivot parts of the rear suspension arms are rotatably supported by the front and rear vertical frames.

The invention of Claim 2 is the rear wheel suspension device for an all-terrain vehicle according to Claim 1, characterized in that the upper and lower frames are offset from each other to the outside and inside, respectively, in the transverse direction of the vehicle, and the front and rear vertical frames are inclined such that the upper parts of the front and rear vertical frames are located further outside than the lower parts thereof and connect the upper and lower frames.

The invention of Claim 3 is the rear wheel suspension device for an all-terrain vehicle according to Claim 1 or 2, characterized in that each of the front and rear vertical frames is constituted of a pair of side walls and a bottom wall integrally joining the side walls and has a generally U-shaped transverse cross-section with the open side facing outside in the transverse direction of the vehicle, and the

pivot parts of the rear suspension arms are located within the U-shape of the front and rear vertical frames and pivoted on support pins extending through the side walls.

The invention of Claim 4 is the rear wheel suspension device for an all-terrain vehicle according to any one of Claims 1 to 3, characterized in that the rear wheel suspension device is a double wishbone type wheel suspension device, and all the four pivot parts of the upper and lower suspension arms are rotatably supported by the front and rear vertical frames.

[Effects of the Invention]

According to the rear wheel suspension device of the invention described in Claim 1, since the upper and lower frames extending in the longitudinal direction of the vehicle are connected by the front and rear vertical frames extending vertically, and since the pivot parts of the rear suspension arms are rotatably supported by the front and rear vertical frames, the degree of freedom in the mounting positions of the rear suspension arms is enhanced without changing the basic structure of the body frame.

Also, since the rear suspension arms are rotatably supported directly by the front and rear vertical frames, conventionally used brackets are unnecessary and there is no need to control the welding strength. This is advantageous from the viewpoint of the strength and production cost.

In the invention of Claim 2, since the front and rear vertical frames are inclined such that the upper parts of the front and rear vertical frames are located further outside than the lower parts thereof, the rolling performance of the vehicle in cornering is improved.

In the invention of Claim 3, since each of the front and rear vertical frames has a generally U-shaped transverse cross-section with the open side facing outside, and since the pivot parts of the rear suspension arms are located

within the U-shape of the front and rear vertical frames and pivoted on support pins extending through the side walls, the degree of freedom in the mounting positions of the rear suspension arms in the vertical direction is enhanced.

In the invention of Claim 4, all the four pivot parts of the upper and lower suspension arms of the double wishbone type wheel suspension device are rotatably supported by the front and rear vertical frame, the degree of freedom in the mounting position of the rear suspension is further enhanced.

[Embodiment of the Invention]

An embodiment of the present invention is described with reference to the attached figures.

FIGs. 1 to 13 illustrate a front wheel suspension device for an all-terrain vehicle constructed in accordance with an embodiment of the present invention.

FIGs. 1 and 2 are side and top plan views of the all-terrain vehicle, respectively.

FIG. 3 is a side view of an engine unit.

FIG.4 is a schematic structural view of the engine unit, as seen in a top plan view.

FIGs 5 and 6 are schematic side and top plan views of a shift mechanism of the engine unit.

FIGs. 7 and 8 are side and top plan views of a body frame, respectively.

FIG. 9 is a perspective view of the body frame.

FIGs. 10 and 11 are side and cross-sectional front (cross-section taken along the line XI-XI in FIG. 10) views of the front wheel suspension device.

FIGs. 12 and 13 are side and cross-sectional plan (cross-section taken along the line XIII-XIII in FIG. 12) views of the rear wheel suspension device. Additionally, the terms "right," "left," "front" and "rear" mean right, left, front and rear sides which are defined when a rider is seated in the seat.

In the figures, the reference numeral 1 indicates an all-terrain vehicle. The vehicle 1 has front and rear wheels 3, 4 that mount balloon tires for running on the rough ground on each right front, left front, right rear and left rear end of a body frame 2. The vehicle 1 has a seat 5 for two riders arranged at a generally center portion of the body frame 2 in a fore to aft direction. The seat 5 is divided into right and left pieces. The vehicle 1 also has an engine unit 6 below the seat 5.

The body frame 2 has a power transmission device 11 that distributes the power from the engine unit 6 to front and rear drive shafts 7, 8 and transmits the power to the front and rear wheels 3, 4 through front and rear differentials 9 and 10. The body frame 2 also has a steering device 13 that transmits a rotational movement of a steering wheel 12 which is disposed in front of the seat 5 to the front wheel 3. The body frame 2 further has front and rear wheel suspension devices 14, 15 that suspend the respective right and left front and rear wheels 3, 4 such that those wheels 3, 4 can independently swing up and down. In addition, a hood 16 is arranged in a front area of the body frame 2 to have open and closed positions, and a carrier 17 is arranged in the rear of the seat 5.

The seat 5 is divided into right and left pieces 31, 30. The right and left pieces 31, 30 are detachably arranged at a top and front portion of the rear frame 22 and are transversely spaced apart from each other. Each seat piece 31, 30 is provided with a seat cushion 31a, 30a and a seatback 31b, 30b that is united with the seat cushion 31a, 30a, respectively. The steering wheel 12 is positioned in front of the left seat piece 30.

The engine unit 6 is provided with a water-cooled, four stroke cycle, single cylinder engine 35, and a transmission case 38 that is coupled to a front portion of the engine 35

and includes a crankcase 37a enclosing a crankshaft 37 and a belt case 36a enclosing a V-belt type continuously variable transmission 36. The engine 35 has a structure that includes the crankcase 37a that encloses the crankshaft 37 transversely and horizontally extending, and a cylinder block 35b, a cylinder head 35c and a head cover 35d those of which are integrated and coupled to the crankcase 37a. A front wall 35e of the cylinder head 35c has an intake port 35f, and a rear wall 35g thereof has a pair of exhaust ports 35h.

The belt case 36a is connected to a left wall of the crankcase 37a, and encloses the V-belt type continuously variable transmission 36. The continuously variable transmission 36 is constructed to include a drive pulley 36d attached to the crankshaft 37, a driven pulley 36b attached to an output shaft 39 that extends parallel to the crankshaft 37 and a V-belt 36c wound around the drive pulley 36d and the driven pulley 36b.

The engine output from the output shaft 39 is transmitted to the front and rear drive shafts 7, 8 through a high, low and forward, reverse change mechanism 34 and enclosed within the crankcase 37a, and a bevel gear mechanism 40.

A rear wall of the belt case 36a has an air inlet 36e through which air for cooling is introduced, and a front wall thereof has an air outlet 36f through which the air is discharged. A cooling air intake duct 67 extending vertically is connected to the air inlet 36e. The cooling air intake duct 67 is located between the right and left seat pieces 31, 30 and behind the seatbacks 30b, 31b. The cooling air intake duct 67 has an upper end port 67b which is located in a position higher than the seating surfaces of the seat cushions 30a, 31a and opens toward the front of the vehicle. A cooling air discharge duct 68 is connected to the air outlet 36f. The cooling air discharge duct 68 is erected vertically and extends from the upper end generally

horizontally backward below the left seat cushion 30a. The cooling air discharge duct 68 has a rear end downstream port 68b which opens toward the rear of the vehicle below a rear part of the seat cushion 30a.

The engine unit 6 is mounted onto the body frame 2 such that the output shaft 39 is positioned in front of the crankshaft 37, the crankshaft 37 and the output shaft 39 are placed below the seat 5, and a center line of the engine unit 6, which extends through its cylinder axis A, extends between the right and left seat pieces 31, 30 and is centrally positioned in the transverse direction relative to the vehicle body.

The major part of both the cylinder block 35b and the cylinder head 35c of the engine 35 is placed in the rear of the respective rear ends of the seatbacks 31b, 30b of the right and left seats 31, 30 in the left side view of the vehicle. Also, the cylinder axis A slants upward approximately 45 degrees relative to, for example, a horizontal line.

An air intake device 45 extending forward relative to the vehicle body is connected to the front wall 35e of the cylinder head 35c, while an exhaust device 46 extending rearward relative to the vehicle body is connected to the rear wall 35g. The exhaust device 46 is provided with a pair of exhaust pipes 47, 47 which are coupled to the rear wall 35g to be connected to the respective exhaust ports 35h, and an exhaust muffler 48 which is coupled to each downstream end of the exhaust pipes 47. Each exhaust pipe 47 has a wavy shape that serpentines up and down in the side view. The muffler 48 is disposed around a rear end of the body frame 2 to transversely extend.

The intake device 45 is constructed such that a downstream end of the throttle body (carburetor) 50 is coupled to the front wall 35e through an intake pipe 49 to be connected to

the intake port 35f, a downstream end of the intake duct 51 is coupled to an upstream end of the throttle body 50 through an accumulator 53, and an air cleaner 52 is coupled to an upstream end of the intake duct 51.

The throttle body 50 has a throttle valve 50a that opens and closes an intake passage. The accelerator pedal is connected to the throttle valve 50a through a throttle control cable (not shown). The air cleaner 52 is disposed behind and in the proximity of the hood 16 between the right and left front wheels 3.

A shift lever 42 is disposed at a front end of a space generally formed between the right and left seat pieces 31, 30. The shift lever 42 is used to change the shift positions among parking, forward H-N-L and reverse positions. The shift lever 42 is positioned above and in the proximity of the transmission case 38 of the engine unit 6. The shift lever 42 and the foregoing change mechanism 34 are connected with each other through a linkage mechanism 41.

According to this embodiment, because the engine unit 6 is mounted such that the output shaft 39 and the crankshaft 37 are positioned below the seat 5, and the output shaft 39 is positioned in front of the crankshaft 37, the cylinder head 35c of the engine unit 6 is inevitably directed rearward. The engine unit 6 thus can be mounted onto the body frame 2 with a small rearward protrusion of the engine unit 6 without interfering the seat 5 or the feet of the riders. As a result, the wheelbase can be shortened, and thereby the vehicle body can be compact.

Also, because the cylinder head 35c is directed rearward, the engine heat is inhibited from affecting the riders. Hence, the riders can directly change seats between the right and left seat pieces 31, 30.

In the illustrated embodiment, a certain part of the cylinder block 35b and the cylinder head 35c of the engine 35

projects rearward than the rear end of the seatback 30b, 31b, and the cylinder axis A inclines upward and rearward. Thus, the cylinder block 35b and the cylinder head 35c both having much heat can be spaced apart from the seat 5 or the riders, and therefore the influence by the engine heat can be avoided.

Also, the intake device 45 that extends forward is connected to the front wall 35e of the cylinder head 35c positioned between the right and left seat pieces 31, 30, while the exhaust device 46 that extends rearward is connected to the rear wall 35g of the cylinder head 35b. Because of the construction, the engine heat is prevented from affecting the intake device, and therefore a stable engine output can be assured. Also, the engine heat can be discharged rearward relative to the vehicle body, the exhaust system can be spaced apart from the fuel supply system. In these standpoints, the influence by the engine heat can be avoided.

Next, the body frame 2 is described.

As shown in FIGs. 1, 2, 7, 8 and 9, the body frame 2 of this embodiment is provided with a main frame 20, a front frame 21, a rear frame 22 and a compartment frame 24. The main frame 20 is provided with right and left side members 18, 18 extending in the longitudinal direction of the vehicle and cross members 19, 19', 19" that couple respective front, center and rear portions of the side members 18, 18. The front frame 21 stands on a front portion of the main frame 20, and the rear frame 22 stands on a rear portion thereof. The compartment frame 24 is disposed between the front frame 21 and the rear frame 22 of the main frame 20 and forms a vehicle compartment in conjunction with the main frame 20.

The main frame 20 has a center frame portion 20a located generally at the center in the longitudinal direction of the main frame 20 and supporting the engine unit 6, and front and rear suspension supporting frame portions 20b, 20c which are

located in front of and behind the center frame portion 20a, respectively, and support the respective front and rear suspension devices 14, 15 in conjunction with the front and rear frames 21, 22. The center frame portion 20a is extended outward in the transverse direction of the vehicle further than the front and rear suspension supporting frame portions 20b, 20c. More specifically, the main frame 20 has a structure as described below.

Each of the right and left side members 18 is divided into front and rear frame members 80, 81 with a rectangular transverse cross-section. Each front frame member 80 has a linear front portion 80a which constitutes the front suspension supporting frame portion 20a, a center portion 80b which linearly extends backward from the front portion 80a and located at the same transverse position as the front portion 80a to form a part of the center frame portion 20a, and a rear end curved portion 80c which extends transversely outward from the rear end of the center portion 80b.

Each rear frame member 81 has a linear rear portion 81a which constitutes the rear suspension supporting frame portion 20c, a center portion 81c which extends transversely outward from the front end of the rear portion 81a and then linearly forward to form a part of the center frame portion 20a, and a front end curved portion 81d which extends transversely inward from the front end of the center portion 81c. The center portions 80b, 81c are overlapped in the transverse direction of the vehicle as seen from a side of the vehicle.

The front end curved portion 81d of the rear frame member 81 is joined by welding to the outer wall of the front frame member 80 at a position in the vicinity of the boundary between the front portion 80a and the center portion 80b. The rear end curved portion 80c of the front frame member 80 is joined by welding to the inner wall of an intermediate

part of the center portion 81c of the rear frame member 81. The center portions 81c of the right and left rear frame members 81, 81, that is, the center frame portion 20a is extended outward in the transverse direction of the vehicle further than the front portions 80a of the front frame members 80 and the rear portions 81a of the rear frame members 81, that is, the front suspension supporting frame portion 20b and the rear suspension supporting frame portions 20c. The engine unit 6 is mounted on the cross members 19' and 19" connecting the center portions 81c of the right and left rear frame members 81 and the center portions 80b of the right and left front frame members 81. The center portions 80b of the right and left front frame members 80 and the center portions 81c of the right and left rear frame members 81 are aligned in the transverse direction of the vehicle with prescribed intervals therebetween, and the floor panel 23 is placed over the right and left center portions 80b, 81c.

The rear frame 22 has right and left seat frame portions 22a on which the right and left seat pieces 31, 30 are mounted, respectively, and a rear suspension frame portion 22b which constitutes an upper part of the rear suspension supporting frame portion 20c.

Each of the seat frame portions 22a has U-shaped front and rear post members 82, 83 joined by welding to the center portion 81c of the rear frame member 81, a square cylindrical upper frame member 84 joined by welding to upper ends of the front and rear post members 82, 83 and extending rearward generally along the rear frame member 81, a seat frame member 85 extending outward from the center portion 81c and then upward, and a steel plate seat cross member 86 transversely connecting the seat frame member 85 and the upper frame member 84 and joined by welding thereto.

An engine frame member 87 extending transversely connects

the right and left seat cross members 86, 86. The engine frame member 87 is constituted of a square pipe 87b extending transversely and L-shaped right and left brackets 87a, 87a made from steel plates and joined by welding to both right and left ends, respectively, of the square pipe 87b. The brackets 87a are detachably fixed to the seat cross members 86 with bolts 88, 88.

The engine 35 is surrounded by the front and rear post members 82, 83 and the upper frame members 84 on the right and left of the engine 35, the cross members 19', 19' under the engine 35, and the engine frame member 87 above the engine 35.

The engine frame member 87 is disposed such that the square pipe 87b thereof is positioned above the cylinder head 35c and the head cover 35d of the engine 35. The engine frame member 87 connects the upper frame members 84 via the right and left seat cross members 86. When the engine frame member 87 is removed by loosening the bolts 88, a maintenance work space is created around the cylinder head 35c.

According to the body frame 2 of this embodiment, since the engine frame member 87 located above the engine 35 is detachable, a space necessary for the engine maintenance work can be created when the engine frame member 87 is removed by loosening the bolts 88, and thereby the maintainability is enhanced. When the engine frame member 87 is fixed with the bolts after the maintenance work has been completed, required engine support rigidity and frame rigidity can be achieved.

Also, the engine frame 87 located above the cylinder head 35c and the head cover 35d of the engine 35 is detachable, the maintainability around the cylinder head 35c and the head cover 35d, which need frequent maintenance, is enhanced. In addition, the engine frame member 87 can be easily attached and detached since the worker can do it with his face down.

According to the body frame 2 of this embodiment, since the

center portions 81c of the right and left side members 18 are extended outward in the transverse direction of the vehicle further than the front and rear portions 80a, 81a, and since the right and left side members 18 are divided into front and rear frame members 80, 81 and the center portions 80b, 81c of the front and rear frame members 80, 81 are aligned in the transverse direction with prescribed intervals therebetween, the body frame 2 can be formed by simply connecting the front and rear frame members 80, 81 by welding and the rigidity of the extended portions of the side members 18 against bending moment is enhanced without increasing the number of parts as in the conventional case of providing additional cross members.

Each of the front frame members 80 has the rear end curved portions 80c curved outward, and each of the rear frame members 81 extends forward from the rear portion 81a curved outward and has the front end curved portion 81d curved inward. The front end curved portions 81d of the rear frame members 81 are joined by welding to the outer walls of the front frame members 80, and the rear end curved portions 80c are joined by welding to the inner walls of the rear frame members 81. Thus, the bending of the frame members is easier than bending one side member at an intermediate portion into a convex shape as in the conventional case, and the frame rigidity against bending moment is enhanced.

Also, since the front and rear frame members 80, 81 are square pipes with rectangular vertical cross-section, the frame rigidity is further enhanced.

Next, the rear wheel suspension device 15 is described.

The rear wheel suspension device 15 of this embodiment is a double wishbone type suspension device having upper and lower rear suspension arms 90, 91 which are disposed on the right and left sides of a rear portion of the body frame 2 and suspend the right and left wheels 4, 4 such that those wheels

4, 4 can independently swing up and down. The outer ends of the upper and lower rear suspension arms 90, 91 are connected by link members 92, and the rear wheels 4 are rotatably supported by the link members 92. Shock absorbers (not shown) are interposed between the upper rear suspension arms 90 and the upper frame members 84.

Although the upper frame members 84 located above the rear suspension supporting frame portion 20c and supporting the rear wheel suspension device 15 in conjunction with the rear suspension supporting frame portion 20c extend generally in parallel to the rear frame members 81, the rear portions 84a of the upper frame members 84 are offset to the outside in the transverse direction of the vehicle with respect to the rear portions 81a of the rear frame members 81.

The rear portions 84a of the upper frame members 84 and the rear portions 81a of the rear frame members 81 are connected by front and rear vertical frame members 94, 95 extending vertically and joined by welding thereto. The front and rear vertical frame members 94, 95 respectively comprise a pair of front and rear side walls 94a, 94a and 95a, 95a, and bottom walls 94b, 95b integrally connecting the front and rear side walls 94a, 94a and 95a, 95a and have a U-shape which opens outward in transverse cross-section.

The front and rear vertical frame members 94, 95 are arranged at a prescribed interval in the longitudinal direction and inclined such that the upper parts of them are located further outside than the lower parts thereof. Thus, the upper rear suspension arms 90 are shorter in length than the lower rear suspension arms 91, and thereby the rear wheels 4 can swing up and down generally vertically.

Upper and lower mount members (pivot parts) 90a, 91a are fixed to the front and rear base ends of the upper and lower rear suspension arms 90, 91, respectively, with their axis extending in the longitudinal direction of the vehicle. The

four mount members 90a, 91a are placed within the U-shape of the front and rear vertical frame members 94, 95, and pivoted on support pins 96 extending through the front and rear walls 94a, 95a.

According to the rear suspension device 15 of this embodiment, since the rear portions 84a, 81a of the upper and lower frame members 84, 81 extending in the longitudinal direction of the vehicle are connected by the front and rear vertical frame members 94, 95 extending vertically, and the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are rotatably supported by the front and rear vertical frame members 94, 95, the degree of freedom in the mounting positions of the upper and lower rear suspension arms 90, 91 in the vertical direction is enhanced without changing the basic structure of the body frame 2.

Also, since the front and rear vertical frame members 94, 95 have U-shaped transverse cross-section, and the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are rotatably supported directly by the U-shaped front and rear vertical frame members 94, 95, conventionally used brackets are unnecessary and there is no need to control the welding strength. This is advantageous from the viewpoint of strength and production cost.

In this embodiment, since the front and rear vertical frame members 94, 95 are inclined such that the upper parts of them are located further outside than the lower parts thereof so that the upper rear suspension arms 90 can be shorter in length than the lower rear suspension arms 91, the rolling performance of the vehicle in cornering is improved.

Since the front and rear vertical frame members 94, 95 have a U-shape with the open side facing outside, and since the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are placed within the U-shape of the front and rear vertical frame members 94, 95 and pivoted on the support

pins 96, the degree of freedom in the mounting position of the upper and lower rear suspension arms 90, 91 in the vertical direction is enhanced.

Also, all the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are rotatably supported by the front and rear vertical frame members 94, 95, the degree of freedom in the mounting position of the rear suspension is further enhanced.

Next, the rear wheel suspension device 14 is described.

The front wheel suspension device 14 of this embodiment has upper and lower front suspension arms 100, 101 disposed on the right and left sides of a front portion of the body frame 2 which suspend the right and left front wheels 3, 3 such that those wheels 3, 3 can independently swing up and down, and shock absorbers (not shown) disposed between the upper front suspension arms 100 and the body frame 2. The outer ends of the upper and lower rear suspension arms 100, 101 are connected by link members 102, and the front wheels 3 are rotatably supported by the link members 102.

Front and rear suspension frame members 103, 104 which constitute a part of the front frame 21 is joined by welding to the front portion 80a of each of the right and left front frame members (lower frames) 80 of the body frame 2 with a prescribed interval in the longitudinal direction therebetween. The front suspension frame members 103 extend vertically from the front ends of the front frame members 80 and then obliquely upward and backward. The rear suspension frame members 104 extend in parallel to the front suspension frame members 103 and have upper ends joined by welding to the front suspension frame members 103. Each pair of the front and rear suspension frame members 103, 104 are connected by a reinforcement 105 extending in the longitudinal direction, and the right and left rear suspension frame members 104 are connected by a reinforcement

106 extending in the transverse direction.

Each of the front portions 80a of the front frame members 80 has a rectangular transverse cross-section, and has a flat vertical wall 80d on the outside. The front and rear suspension frame members 103, 104 have flat vertical walls 103a, 104a, respectively, on the outside.

Lower brackets 107, 108 with U-shaped transverse cross-section are joined by welding to the outer vertical walls 80d of the front frame members 80 with a prescribed interval in the longitudinal direction therebetween. The front lower brackets 107 are disposed with their open sides facing up, and the rear lower brackets 108 are disposed with their open sides facing down.

U-shaped upper brackets 109, 110 are joined by welding to the outer vertical walls 103a, 104a of the front and rear suspension frame members 103, 104, respectively. The front upper brackets 109 are disposed with their open sides facing outside, and the rear upper brackets 110 are disposed at positions lower than the front upper brackets 109 with their open sides facing outside. The distance between the upper brackets 109, 110 is smaller than that between the lower brackets 107, 108.

Upper and lower mount members 100a, 101a (pivot parts) are fixed to the front and rear base ends of the upper and lower front suspension arms 100, 101, respectively, with their axes in the longitudinal direction of the vehicle. The upper and lower mount members 100a, 101a are slightly inclined such that the front sides of them are higher than the rear sides thereof.

The upper mount members 100a are pivoted on upper support pins 111 attached to the upper brackets 109, 110. The lower mount members 101a are pivoted on lower support pins 112 attached to the lower brackets 107, 108. The rear lower mount members 101a are located at positions lower than the

front lower mount members 101a. The axes connecting the lower mount members 101a and the axes connecting the upper mount members 100a are parallel to each other and slightly inclined upward and forward.

According to the front wheel suspension device 14 of this embodiment, since the outer vertical walls 80d of the front frame members 80 and the outer vertical walls 103a, 104a of the front and rear suspension frame members 103, 104 are flat, and the upper and lower brackets 107 to 110 for supporting the upper and lower front suspension arms 100, 101 are joined by welding to the outer vertical walls 80d, 103a, 104a, the mounting positions of the brackets 107 to 110 can be set freely and the degree of freedom in the swing angle of the front suspension is enhanced without changing the basic structure of the body frame 2.

Also, in this embodiment, since the rear mount members 100a, 101a of the upper and lower front suspension arms 100, 101 are located in positions lower than the front mount members 100a, 101a, respectively, the attitude of the vehicle in climbing over an obstruction such as a large stone can be stabilized.

Also, since the front frame members 80 have a rectangular transverse cross-section and the front suspension arms 101 are supported on the outer vertical walls 80d of the front frame members 80, the front frame members 80 can be simple in shape and has high frame rigidity.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 is a side view of an all-terrain vehicle to explain an embodiment of the present invention.

[FIG. 2]

FIG. 2 is a top plan view of the all-terrain vehicle.

[FIG. 3]

FIG. 3 is a side view of an engine unit of the all-terrain

vehicle.

[FIG. 4]

FIG. 4 is a schematic structural view of the engine unit, as seen in a top plan view.

[FIG. 5]

FIG. 5 is schematic side view of a shift mechanism of the engine unit.

[FIG. 6]

FIG. 6 is a top plan view of the shift mechanism.

[FIG. 7]

FIG. 7 is a perspective view of a body frame of the all-terrain vehicle.

[FIG. 8]

FIG. 8 is a top plan view of the body frame.

[FIG. 9]

FIG. 9 is a perspective view of the body frame.

[FIG. 10]

FIG. 10 is a side view of a front wheel suspension device of the all-terrain vehicle.

[FIG. 11]

FIG. 11 is a cross-sectional front view (cross-section taken along the lone XI-XI in FIG. 10) of the front wheel suspension device.

[FIG. 12]

FIG. 12 is a side view of a rear wheel suspension device of the all-terrain vehicle.

[FIG. 13]

FIG. 13 is a cross-sectional plan view (cross-section taken along the lone XIII-XIII in FIG. 12) of the rear wheel suspension device.

[Description of Reference Numerals]

1	all-terrain vehicle
2	body frame
4	rear wheel

15 rear wheel suspension device

81 rear frame member (lower frame)

84 upper frame member (upper frame)

90, 91 rear suspension arm

90a, 91a mount member (pivot part)

94 front vertical frame member

95 rear vertical frame member

96 support pin

[Document Name] Abstract

[Abstract]

[Problem to be Solved] To provide a rear wheel suspension device for an all-terrain vehicle in which the degree of freedom in the mounting positions of rear suspension arms is enhanced without changing the basic structure of the body frame.

[Solution] In a rear wheel suspension device for an all-terrain vehicle, a body frame 2 has a rear part constituted of upper frame members 84 and lower frame members (lower frames) 81 extending in the longitudinal direction of the vehicle, and front and rear vertical frames 94, 95 extending vertically and connecting the upper and lower frame members 84, 81, and mount members 90a, 91a of upper and lower rear suspension arms 90, 91 are rotatably supported by the front and rear vertical frames 94, 95.

[Selected Drawing] Fig. 12

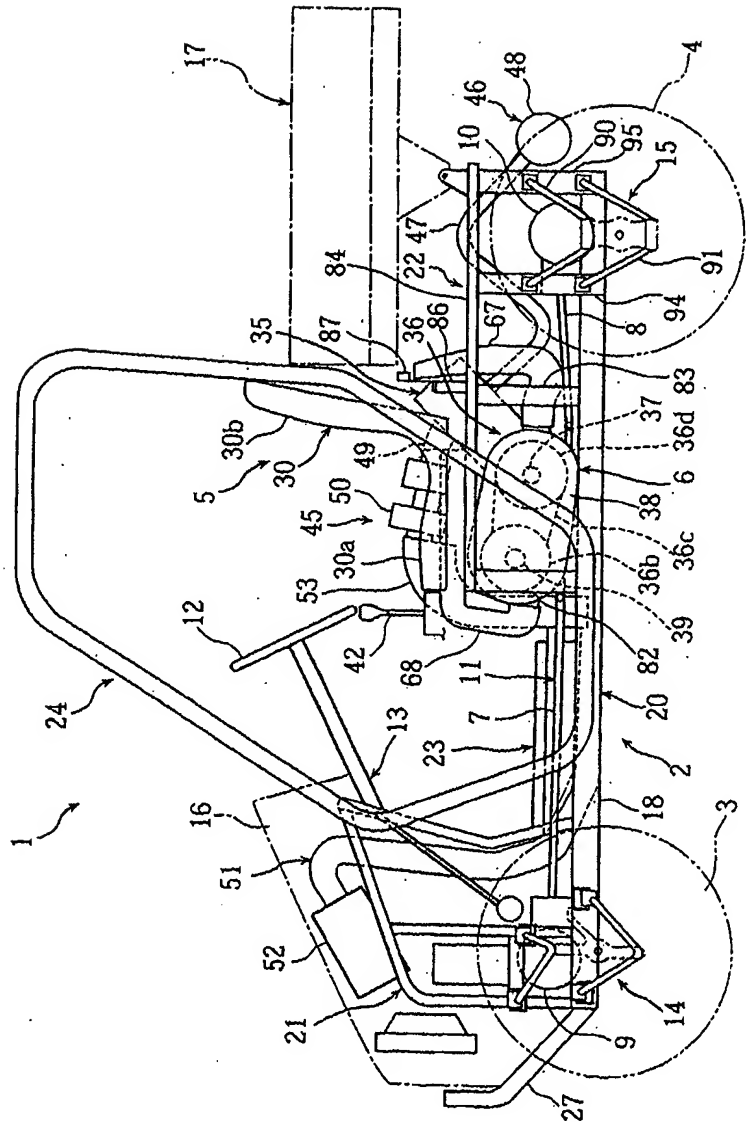
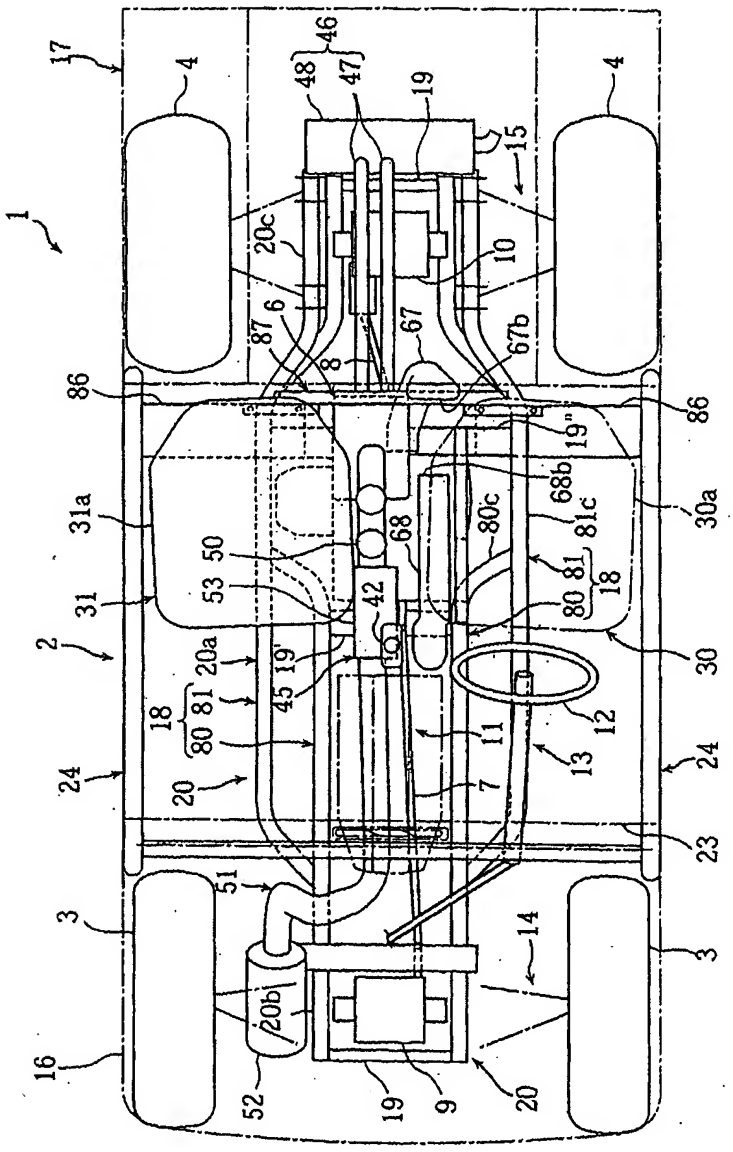


FIG. 1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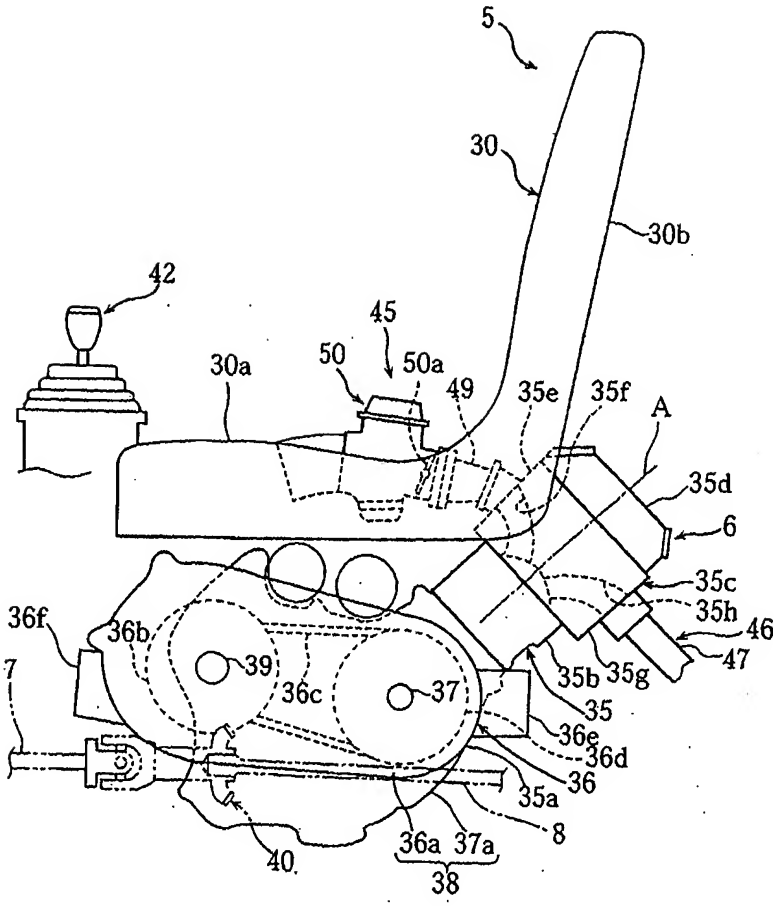
6
7
8
9
10
11
12
13
14
15
16
17
18
19
19'
19"
20
20a
20b
20c
23
24
30
30a
31
31a
42
45
46
47
48
50
51
52
53
67
67b
68
68b
80
80c
81
81c
86
87

FIG. 2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30b
42
45
30a
50
50a
49
35e
35f
A
35d
6
35c
35h
46
47
36f
36b
39
36c
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35b
35g
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36e
36d
36
35a
8
40
36a
37a
38

FIG. 3

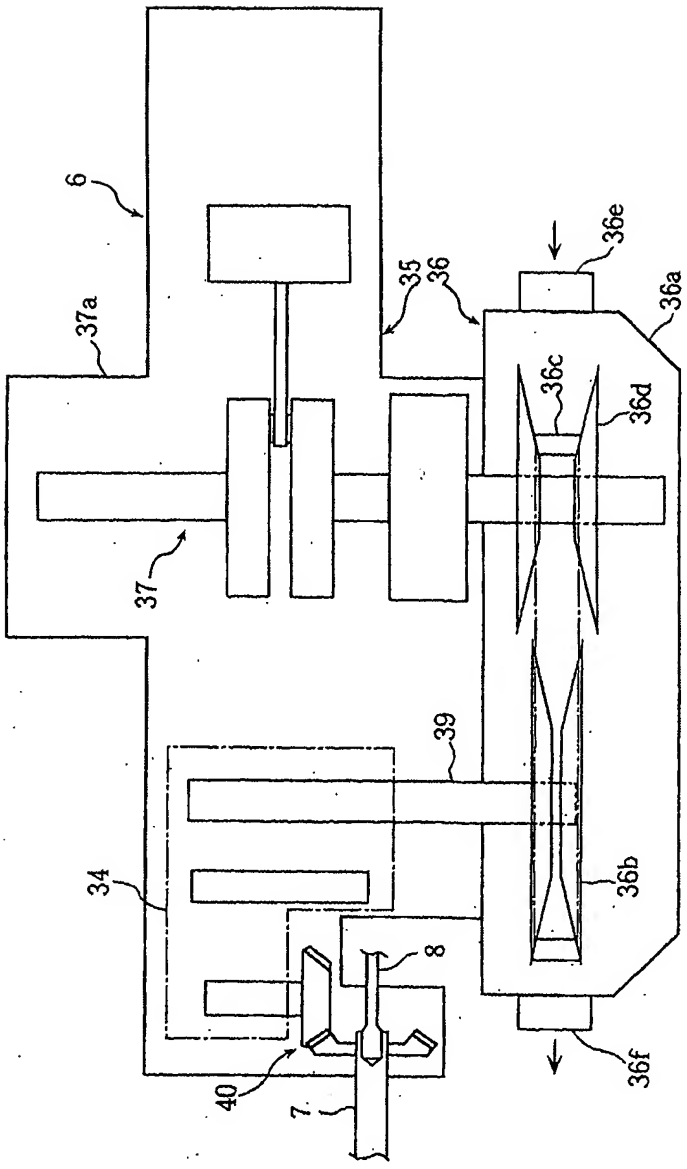


FIG. 4

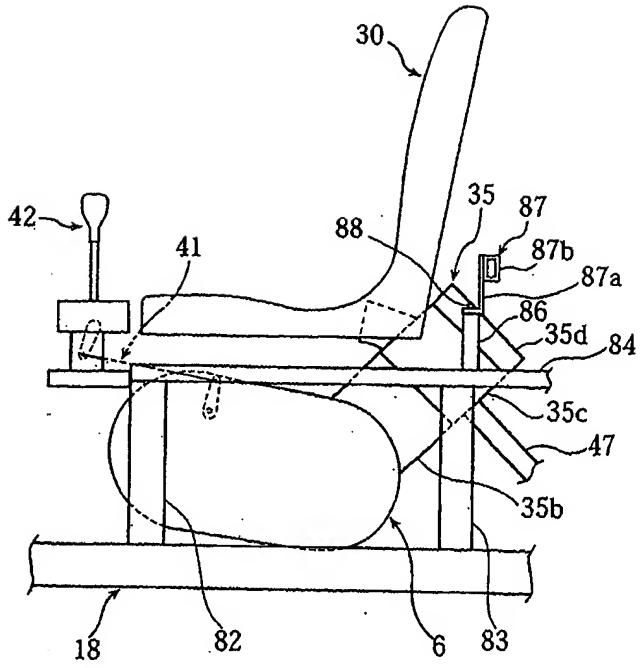


FIG. 5

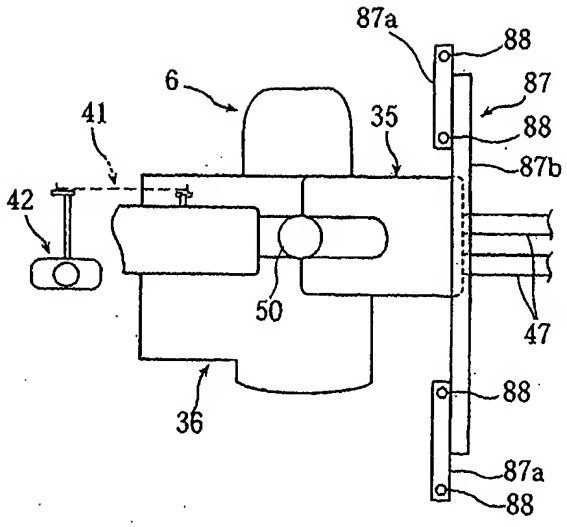


FIG. 6

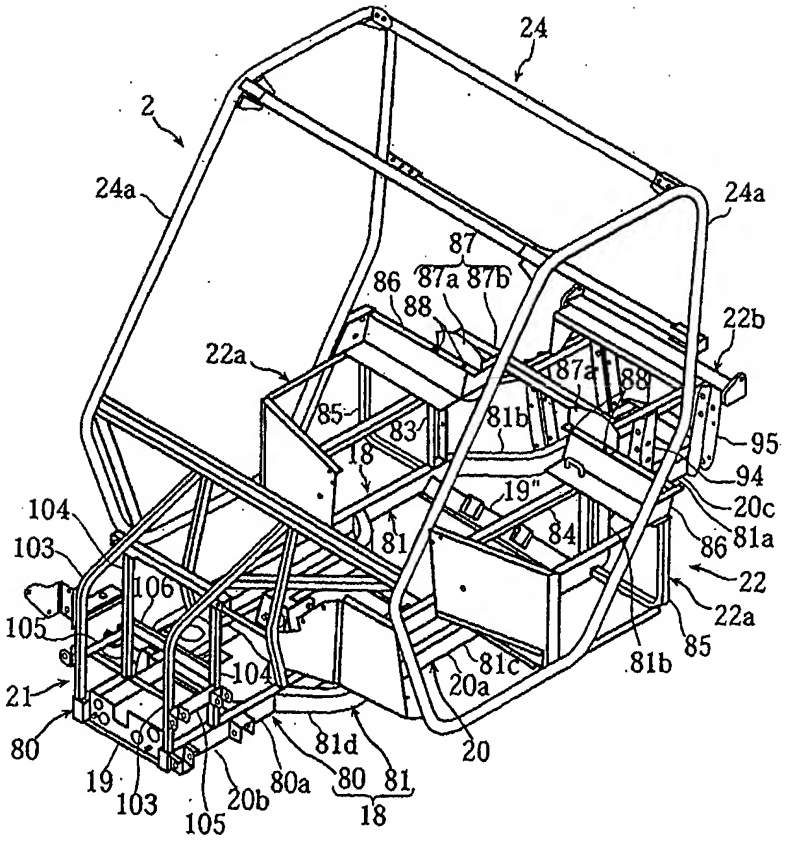
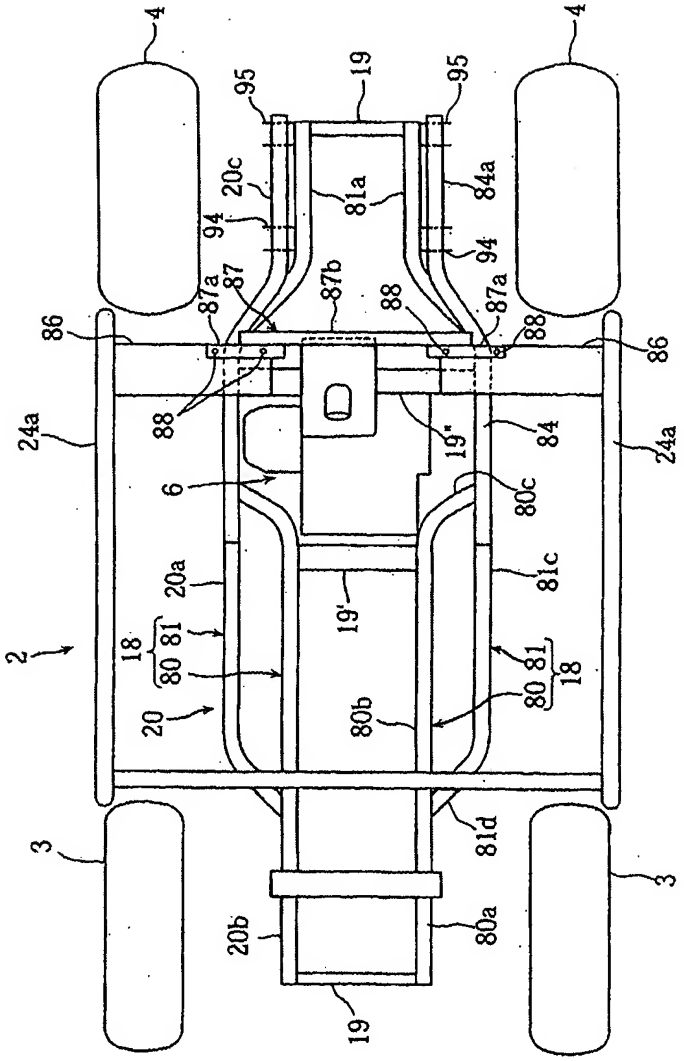

24
2
24a
24a
87
86
87a
87b
88
22b
22a
187a
88
85
83
81b
95
18
94
19"
20c
104
81
84
81a
103
86
106
22
105
22a
104
85
81c
81b
21
20a
80
81d
20
19
80a
80
81
103
20b
105
18

FIG. 7


4
95
19
95
4
20c
81a
84a
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94
87a
87
87b
88
87a
88
86
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88
24a
19"
84
24a
6
80c
20a
81c
2
18
81
80
19'
81
80
18
20
80b
81d
3
3
20b
80a
19'

FIG. 8

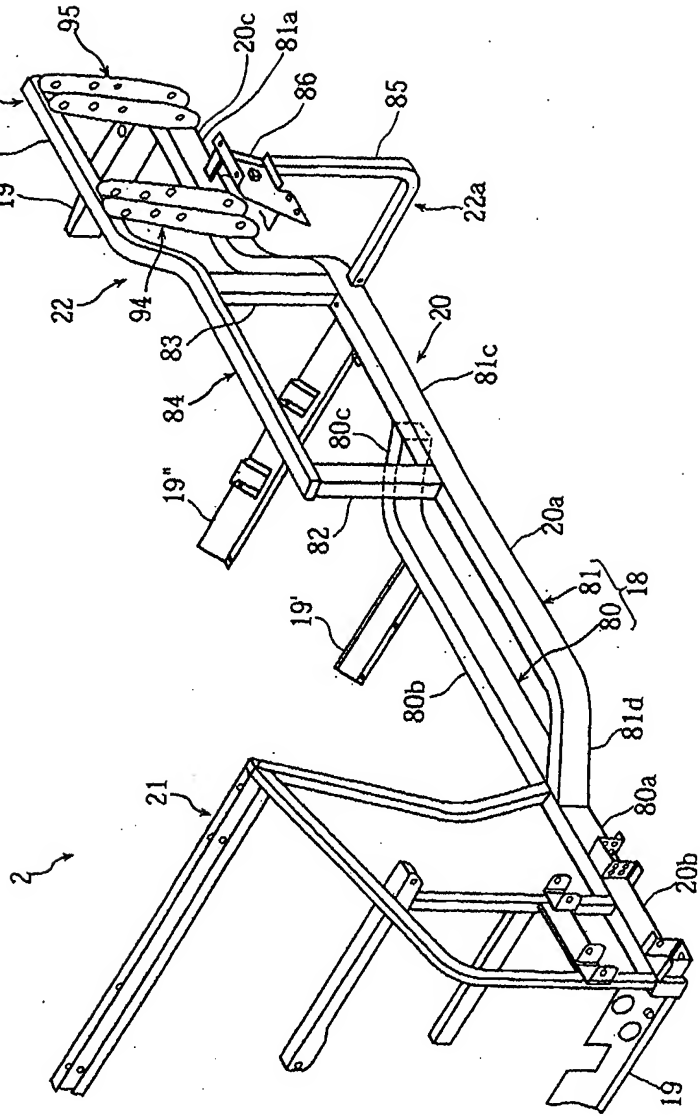

95
20c
81a
22b
86
85
84a
19
22a
22
94
83
20
81c
84
80c
19"
82
20a
81
18
80
19'
80b
81d
21
80a
2
20b
19

FIG. 9

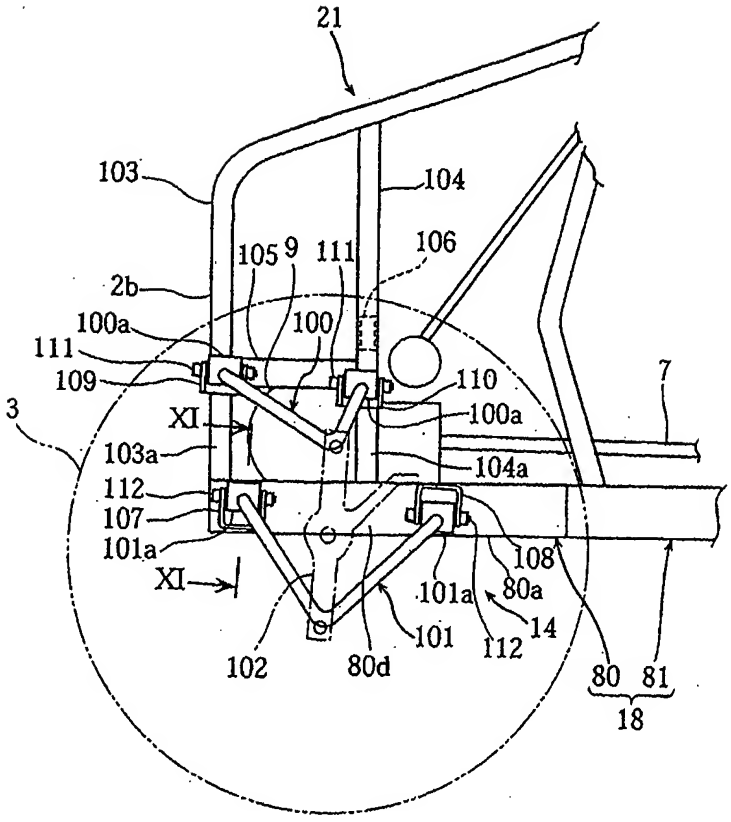

21
103
104
105
9
111
106
2b
100a
100
111
109
110
7
3
XI
100a
103a
104a
112
107
101a
XI
108
101a
80a
14
101
112
102
80d
80
81
18

FIG. 10

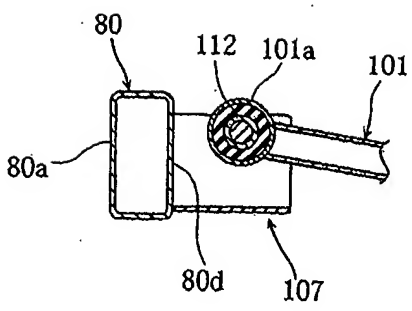


FIG. 11

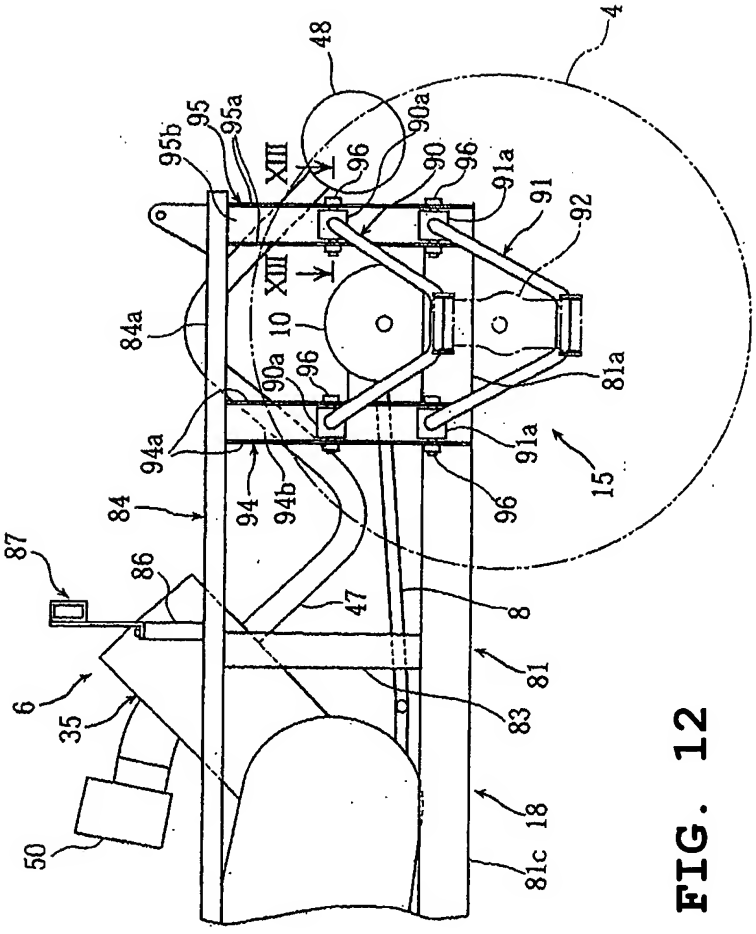

4
48
95b
95
95a
XIII
96
90a
90
96
91a
91
92
84a
10
XIII
90a
96
81a
94a
91a
15
84
94
94b
96
87
86
47
8
6
35
81
83
50
18
81c

FIG. 12

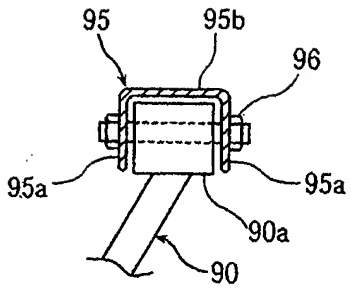


FIG. 13

VERIFICATION OF TRANSLATION

I, undersigned below, hereby declare that:

My name and post office address are as stated below:

That I am knowledgeable in the English language and in the language in which the below identified U.S. Provisional Application was filed, and that I believe the attached English translation of the U.S. Provisional Application No. 60/459,957 filed on April 2, 2003 is a true and complete translation of the above-identified Provisional Application as filed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 10/8/2004

Full Name of the Translator: Yasuhiro Tochigi

Signature of the translator:

Post Office Address: No. 28-11, Shogen, Hamamatsu, Shizuoka 430-0802, Japan

[Document Name] Specification

[Title of the Invention] FRONT WHEEL SUSPENSION DEVICE FOR ALL-TERRAIN VEHICLE

[Claims]

[Claim 1] A front wheel suspension device for an all-terrain vehicle having wheels for running on the rough ground arranged at respective right and left sides of front and rear portions of a body frame, comprising front suspension arms supported by right and left parts of the front portion of the body frame for vertical swinging movement for supporting the front wheels, wherein the body frame has a lower frame extending in the longitudinal direction of the vehicle and having flat side walls on the outside in the transverse direction of the vehicle, and the front suspension arms are rotatably supported on the side walls of the lower frame via brackets.

[Claim 2] The front wheel suspension device for an all-terrain vehicle according to Claim 1, wherein front and rear pivot parts of the front suspension arms are supported at different heights on the flat surfaces of the side walls.

[Claim 3] The front wheel suspension device for an all-terrain vehicle according to Claim 1 or 2, wherein the lower frame has a vertically oriented rectangular cross-section and the front suspension arms are rotatably supported on outer vertical walls of the rectangular lower frame.

[Detailed Description of the Invention]

[Field of the Invention]

This invention relates to a front wheel suspension device for an all-terrain vehicle.

[Prior Art]

An all-terrain vehicle of this type must have a body frame which is light in weight and has high rigidity from the viewpoint of its use. Thus, the body of such an all-terrain

vehicle is usually formed of a steel pipe frame (for example, see Patent Document 1). Also, the front suspension arms for supporting the front wheels for vertical swinging movement are rotatably supported by brackets joined by welding to the pipe frame.

[Patent Document 1]

JP-Y-Hei 06-34213

[Problem to be Solved by the Invention]

When a structure in which front suspension arms are rotatably supported on the pipe frame via brackets is adopted, the degree of freedom in setting the swing angle of the front suspension is so low that the basic structure of the body frame has to be changed in some cases.

This invention has been made to solve the above problem. It is therefore an object of the invention to provide a front wheel suspension device for an all-terrain vehicle in which the degree of freedom in setting the swing angle of the suspension is enhanced.

[Means for Solving the Problem]

The invention of Claim 1 is characterized by a front wheel suspension device for an all-terrain vehicle having wheels for running on the rough ground arranged at respective right and left sides of front and rear portions of a body frame, comprising front suspension arms supported by right and left parts of the front portion of the body frame for vertical swinging movement for supporting the front wheels, in which the body frame has a lower frame extending in the longitudinal direction of the vehicle and having flat side walls on the outside in the transverse direction of the vehicle, and the front suspension arms are rotatably supported on the side walls of the lower frame via brackets.

The invention of Claim 2 is the front wheel suspension device for an all-terrain vehicle according to Claim 1, characterized in that front and rear pivot parts of the front

suspension arms are supported at different heights on the flat surfaces of the side walls.

The invention of Claim 3 is the front wheel suspension device for an all-terrain vehicle according to Claim 1 or 2, characterized in that the lower frame has a vertically oriented rectangular cross-section and the front suspension arms are rotatably supported on outer vertical walls of the rectangular lower frame.

[Effects of the Invention]

According to the front wheel suspension device of the invention described in Claim 1, since the lower frame for rotatably supporting the front suspension arms has flat side walls on the outside in the transverse direction of the vehicle and the brackets are attached to the side walls, the mounting positions of the brackets, and thus the front suspension arms, can be set freely by moving the brackets on the side walls. Thus, the degree of freedom in the swing angle of the suspension is enhanced without changing the basic structure of the body frame.

In the invention of Claim 2, since the front and rear pivot parts of the front suspension arms are positioned at different heights, when the front pivot parts are positioned higher than the rear pivot parts, for example, the attitude of the vehicle in climbing over an obstruction such as a large stone can be stabilized.

In the invention of Claim 3, since the lower frame has a vertically oriented rectangular cross-section and the front suspension arms are rotatably supported on outer vertical walls of the rectangular lower frame, the lower frame can be simple in shape and has high rigidity.

[Embodiment of the Invention]

An embodiment of the present invention is described with reference to the attached figures.

FIGs. 1 to 13 illustrate a front wheel suspension device

for an all-terrain vehicle constructed in accordance with an embodiment of the present invention.

FIGs. 1 and 2 are side and top plan views of the all-terrain vehicle, respectively.

FIG. 3 is a side view of an engine unit.

FIG.4 is a schematic structural view of the engine unit, as seen in a top plan view.

FIGs 5 and 6 are schematic side and top plan views of a shift mechanism of the engine unit.

FIGs. 7 and 8 are side and top plan views of a body frame, respectively.

FIG. 9 is a perspective view of the body frame.

FIGs. 10 and 11 are side and cross-sectional front (cross-section taken along the line XI-XI in FIG. 10) views of the front wheel suspension device.

FIGs. 12 and 13 are side and cross-sectional plan (cross-section taken along the line XIII-XIII in FIG. 12) views of the rear wheel suspension device. Additionally, the terms "right," "left," "front" and "rear" mean right, left, front and rear sides which are defined when a rider is seated in the seat.

In the figures, the reference numeral 1 indicates an all-terrain vehicle. The vehicle 1 has front and rear wheels 3, 4 that mount balloon tires for running on the rough ground on each right front, left front, right rear and left rear end of a body frame 2. The vehicle 1 has a seat 5 for two riders arranged at a generally center portion of the body frame 2 in a fore to aft direction. The seat 5 is divided into right and left pieces. The vehicle 1 also has an engine unit 6 below the seat 5.

The body frame 2 has a power transmission device 11 that distributes the power from the engine unit 6 to front and rear drive shafts 7, 8 and transmits the power to the front and rear wheels 3, 4 through front and rear differentials 9 and

10. The body frame 2 also has a steering device 13 that transmits a rotational movement of a steering wheel 12 which is disposed in front of the seat 5 to the front wheel 3. The body frame 2 further has front and rear wheel suspension devices 14, 15 that suspend the respective right and left front and rear wheels 3, 4 such that those wheels 3, 4 can independently swing up and down. In addition, a hood 16 is arranged in a front area of the body frame 2 to have open and closed positions, and a carrier 17 is arranged in the rear of the seat 5.

The seat 5 is divided into right and left pieces 31, 30. The right and left pieces 31, 30 are detachably arranged at a top and front portion of the rear frame 22 and are transversely spaced apart from each other. Each seat piece 31, 30 is provided with a seat cushion 31a, 30a and a seatback 31b, 30b that is united with the seat cushion 31a, 30a, respectively. The steering wheel 12 is positioned in front of the left seat piece 30.

The engine unit 6 is provided with a water-cooled, four stroke cycle, single cylinder engine 35, and a transmission case 38 that is coupled to a front portion of the engine 35 and includes a crankcase 37a enclosing a crankshaft 37 and a belt case 36a enclosing a V-belt type continuously variable transmission 36. The engine 35 has a structure that includes the crankcase 37a that encloses the crankshaft 37 transversely and horizontally extending, and a cylinder block 35b, a cylinder head 35c and a head cover 35d those of which are integrated and coupled to the crankcase 37a. A front wall 35e of the cylinder head 35c has an intake port 35f, and a rear wall 35g thereof has a pair of exhaust ports 35h.

The belt case 36a is connected to a left wall of the crankcase 37a, and encloses the V-belt type continuously variable transmission 36. The continuously variable transmission 36 is constructed to include a drive pulley 36d attached to the

crankshaft 37, a driven pulley 36b attached to an output shaft 39 that extends parallel to the crankshaft 37 and a V-belt 36c wound around the drive pulley 36d and the driven pulley 36b.

The engine output from the output shaft 39 is transmitted to the front and rear drive shafts 7, 8 through a high, low and forward, reverse change mechanism 34 and enclosed within the crankcase 37a, and a bevel gear mechanism 40.

A rear wall of the belt case 36a has an air inlet 36e through which air for cooling is introduced, and a front wall thereof has an air outlet 36f through which the air is discharged. A cooling air intake duct 67 extending vertically is connected to the air inlet 36e. The cooling air intake duct 67 is located between the right and left seat pieces 31, 30 and behind the seatbacks 30b, 31b. The cooling air intake duct 67 has an upper end port 67b which is located in a position higher than the seating surfaces of the seat cushions 30a, 31a and opens toward the front of the vehicle. A cooling air discharge duct 68 is connected to the air outlet 36f. The cooling air discharge duct 68 is erected vertically and extends from the upper end generally horizontally backward below the left seat cushion 30a. The cooling air discharge duct 68 has a rear end downstream port 68b which opens toward the rear of the vehicle below a rear part of the seat cushion 30a.

The engine unit 6 is mounted onto the body frame 2 such that the output shaft 39 is positioned in front of the crankshaft 37, the crankshaft 37 and the output shaft 39 are placed below the seat 5, and a center line of the engine unit 6, which extends through its cylinder axis A, extends between the right and left seat pieces 31, 30 and is centrally positioned in the transverse direction relative to the vehicle body.

The major part of both the cylinder block 35b and the cylinder head 35c of the engine 35 is placed in the rear of the respective rear ends of the seatbacks 31b, 30b of the right

and left seats 31, 30 in the left side view of the vehicle. Also, the cylinder axis A slants upward approximately 45 degrees relative to, for example, a horizontal line.

An air intake device 45 extending forward relative to the vehicle body is connected to the front wall 35e of the cylinder head 35c, while an exhaust device 46 extending rearward relative to the vehicle body is connected to the rear wall 35g. The exhaust device 46 is provided with a pair of exhaust pipes 47, 47 which are coupled to the rear wall 35g to be connected to the respective exhaust ports 35h, and an exhaust muffler 48 which is coupled to each downstream end of the exhaust pipes 47. Each exhaust pipe 47 has a wavy shape that serpentines up and down in the side view. The muffler 48 is disposed around a rear end of the body frame 2 to transversely extend.

The intake device 45 is constructed such that a downstream end of the throttle body (carburetor) 50 is coupled to the front wall 35e through an intake pipe 49 to be connected to the intake port 35f, a downstream end of the intake duct 51 is coupled to an upstream end of the throttle body 50 through an accumulator 53, and an air cleaner 52 is coupled to an upstream end of the intake duct 51.

The throttle body 50 has a throttle valve 50a that opens and closes an intake passage. The accelerator pedal is connected to the throttle valve 50a through a throttle control cable (not shown). The air cleaner 52 is disposed behind and in the proximity of the hood 16 between the right and left front wheels 3.

A shift lever 42 is disposed at a front end of a space generally formed between the right and left seat pieces 31, 30. The shift lever 42 is used to change the shift positions among parking, forward H-N-L and reverse positions. The shift lever 42 is positioned above and in the proximity of the transmission case 38 of the engine unit 6. The shift lever

42 and the foregoing change mechanism 34 are connected with each other through a linkage mechanism 41.

According to this embodiment, because the engine unit 6 is mounted such that the output shaft 39 and the crankshaft 37 are positioned below the seat 5, and the output shaft 39 is positioned in front of the crankshaft 37, the cylinder head 35c of the engine unit 6 is inevitably directed rearward. The engine unit 6 thus can be mounted onto the body frame 2 with a small rearward protrusion of the engine unit 6 without interfering the seat 5 or the feet of the riders. As a result, the wheelbase can be shortened, and thereby the vehicle body can be compact.

Also, because the cylinder head 35c is directed rearward, the engine heat is inhibited from affecting the riders. Hence, the riders can directly change seats between the right and left seat pieces 31, 30.

In the illustrated embodiment, a certain part of the cylinder block 35b and the cylinder head 35c of the engine 35 projects rearward than the rear end of the seatback 30b, 31b, and the cylinder axis A inclines upward and rearward. Thus, the cylinder block 35b and the cylinder head 35c both having much heat can be spaced apart from the seat 5 or the riders, and therefore the influence by the engine heat can be avoided.

Also, the intake device 45 that extends forward is connected to the front wall 35e of the cylinder head 35c positioned between the right and left seat pieces 31, 30, while the exhaust device 46 that extends rearward is connected to the rear wall 35g of the cylinder head 35b. Because of the construction, the engine heat is prevented from affecting the intake device, and therefore a stable engine output can be assured. Also, the engine heat can be discharged rearward relative to the vehicle body, the exhaust system can be spaced apart from the fuel supply system. In these standpoints, the

influence by the engine heat can be avoided.

Next, the body frame 2 is described.

As shown in FIGs. 1, 2, 7, 8 and 9, the body frame 2 of this embodiment is provided with a main frame 20, a front frame 21, a rear frame 22 and a compartment frame 24. The main frame 20 is provided with right and left side members 18, 18 extending in the longitudinal direction of the vehicle and cross members 19, 19', 19" that couple respective front, center and rear portions of the side members 18, 18. The front frame 21 stands on a front portion of the main frame 20, and the rear frame 22 stands on a rear portion thereof. The compartment frame 24 is disposed between the front frame 21 and the rear frame 22 of the main frame 20 and forms a vehicle compartment in conjunction with the main frame 20.

The main frame 20 has a center frame portion 20a located generally at the center in the longitudinal direction of the main frame 20 and supporting the engine unit 6, and front and rear suspension supporting frame portions 20b, 20c which are located in front of and behind the center frame portion 20a, respectively, and support the respective front and rear suspension devices 14, 15 in conjunction with the front and rear frames 21, 22. The center frame portion 20a is extended outward in the transverse direction of the vehicle further than the front and rear suspension supporting frame portions 20b, 20c. More specifically, the main frame 20 has a structure as described below.

Each of the right and left side members 18 is divided into front and rear frame members 80, 81 with a rectangular transverse cross-section. Each front frame member 80 has a linear front portion 80a which constitutes the front suspension supporting frame portion 20a, a center portion 80b which linearly extends backward from the front portion 80a and located at the same transverse position as the front portion 80a to form a part of the center frame portion 20a,

and a rear end curved portion 80c which extends transversely outward from the rear end of the center portion 80b.

Each rear frame member 81 has a linear rear portion 81a which constitutes the rear suspension supporting frame portion 20c, a center portion 81c which extends transversely outward from the front end of the rear portion 81a and then linearly forward to form a part of the center frame portion 20a, and a front end curved portion 81d which extends transversely inward from the front end of the center portion 81c. The center portions 80b, 81c are overlapped in the transverse direction of the vehicle as seen from a side of the vehicle.

The front end curved portion 81d of the rear frame member 81 is joined by welding to the outer wall of the front frame member 80 at a position in the vicinity of the boundary between the front portion 80a and the center portion 80b.

The rear end curved portion 80c of the front frame member 80 is joined by welding to the inner wall of an intermediate part of the center portion 81c of the rear frame member 81.

The center portions 81c of the right and left rear frame members 81, 81, that is, the center frame portion 20a is extended outward in the transverse direction of the vehicle further than the front portions 80a of the front frame members 80 and the rear portions 81a of the rear frame members 81, that is, the front suspension supporting frame portion 20b and the rear suspension supporting frame portions 20c. The engine unit 6 is mounted on the cross members 19′ and 19″ connecting the center portions 81c of the right and left rear frame members 81 and the center portions 80b of the right and left front frame members 81. The center portions 80b of the right and left front frame members 80 and the center portions 81c of the right and left rear frame members 81 are aligned in the transverse direction of the vehicle with prescribed intervals therebetween, and the floor panel 23 is placed over the right and left center portions 80b, 81c.

The rear frame 22 has right and left seat frame portions 22a on which the right and left seat pieces 31, 30 are mounted, respectively, and a rear suspension frame portion 22b which constitutes an upper part of the rear suspension supporting frame portion 20c.

Each of the seat frame portions 22a has U-shaped front and rear post members 82, 83 joined by welding to the center portion 81c of the rear frame member 81, a square cylindrical upper frame member 84 joined by welding to upper ends of the front and rear post members 82, 83 and extending rearward generally along the rear frame member 81, a seat frame member 85 extending outward from the center portion 81c and then upward, and a steel plate seat cross member 86 transversely connecting the seat frame member 85 and the upper frame member 84 and joined by welding thereto.

An engine frame member 87 extending transversely connects the right and left seat cross members 86, 86. The engine frame member 87 is constituted of a square pipe 87b extending transversely and L-shaped right and left brackets 87a, 87a made from steel plates and joined by welding to both right and left ends, respectively, of the square pipe 87b.The brackets 87a are detachably fixed to the seat cross members 86 with bolts 88, 88.

The engine 35 is surrounded by the front and rear post members 82, 83 and the upper frame members 84 on the right and left of the engine 35, the cross members 19', 19' under the engine 35, and the engine frame member 87 above the engine 35.

The engine frame member 87 is disposed such that the square pipe 87b thereof is positioned above the cylinder head 35c and the head cover 35d of the engine 35. The engine frame member 87 connects the upper frame members 84 via the right and left seat cross members 86. When the engine frame member 87 is removed by loosening the bolts 88, a maintenance work

space is created around the cylinder head 35c.

According to the body frame 2 of this embodiment, since the engine frame member 87 located above the engine 35 is detachable, a space necessary for the engine maintenance work can be created when the engine frame member 87 is removed by loosening the bolts 88, and thereby the maintainability is enhanced. When the engine frame member 87 is fixed with the bolts after the maintenance work has been completed, required engine support rigidity and frame rigidity can be achieved.

Also, the engine frame 87 located above the cylinder head 35c and the head cover 35d of the engine 35 is detachable, the maintainability around the cylinder head 35c and the head cover 35d, which need frequent maintenance, is enhanced. In addition, the engine frame member 87 can be easily attached and detached since the worker can do it with his face down.

According to the body frame 2 of this embodiment, since the center portions 81c of the right and left side members 18 are extended outward in the transverse direction of the vehicle further than the front and rear portions 80a, 81a, and since the right and left side members 18 are divided into front and rear frame members 80, 81 and the center portions 80b, 81c of the front and rear frame members 80, 81 are aligned in the transverse direction with prescribed intervals therebetween, the body frame 2 can be formed by simply connecting the front and rear frame members 80, 81 by welding and the rigidity of the extended portions of the side members 18 against bending moment is enhanced without increasing the number of parts as in the conventional case of providing additional cross members.

Each of the front frame members 80 has the rear end curved portions 80c curved outward, and each of the rear frame members 81 extends forward from the rear portion 81a curved outward and has the front end curved portion 81d curved inward. The front end curved portions 81d of the rear frame members

81 are joined by welding to the outer walls of the front frame members 80, and the rear end curved portions 80c are joined by welding to the inner walls of the rear frame members 81. Thus, the bending of the frame members is easier than bending one side member at an intermediate portion into a convex shape as in the conventional case, and the frame rigidity against bending moment is enhanced.

Also, since the front and rear frame members 80, 81 are square pipes with rectangular vertical cross-section, the frame rigidity is further enhanced.

Next, the rear wheel suspension device 15 is described.

The rear wheel suspension device 15 of this embodiment is a double wishbone type suspension device having upper and lower rear suspension arms 90, 91 which are disposed on the right and left sides of a rear portion of the body frame 2 and suspend the right and left wheels 4, 4 such that those wheels 4, 4 can independently swing up and down. The outer ends of the upper and lower rear suspension arms 90, 91 are connected by link members 92, and the rear wheels 4 are rotatably supported by the link members 92. Shock absorbers (not shown) are interposed between the upper rear suspension arms 90 and the upper frame members 84.

Although the upper frame members 84 located above the rear suspension supporting frame portion 20c and supporting the rear wheel suspension device 15 in conjunction with the rear suspension supporting frame portion 20c extend generally in parallel to the rear frame members 81, the rear portions 84a of the upper frame members 84 are offset to the outside in the transverse direction of the vehicle with respect to the rear portions 81a of the rear frame members 81.

The rear portions 84a of the upper frame members 84 and the rear portions 81a of the rear frame members 81 are connected by front and rear vertical frame members 94, 95 extending vertically and joined by welding thereto. The front and rear

vertical frame members 94, 95 respectively comprise a pair of front and rear side walls 94a, 94a and 95a, 95a, and bottom walls 94b, 95b integrally connecting the front and rear side walls 94a, 94a and 95a, 95a and have a U-shape which opens outward in transverse cross-section.

The front and rear vertical frame members 94, 95 are arranged at a prescribed interval in the longitudinal direction and inclined such that the upper parts of them are located further outside than the lower parts thereof. Thus, the upper rear suspension arms 90 are shorter in length than the lower rear suspension arms 91, and thereby the rear wheels 4 can swing up and down generally vertically.

Upper and lower mount members (pivot parts) 90a, 91a are fixed to the front and rear base ends of the upper and lower rear suspension arms 90, 91, respectively, with their axis extending in the longitudinal direction of the vehicle. The four mount members 90a, 91a are placed within the U-shape of the front and rear vertical frame members 94, 95, and pivoted on support pins 96 extending through the front and rear walls 94a, 95a.

According to the rear suspension device 15 of this embodiment, since the rear portions 84a, 81a of the upper and lower frame members 84, 81 extending in the longitudinal direction of the vehicle are connected by the front and rear vertical frame members 94, 95 extending vertically, and the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are rotatably supported by the front and rear vertical frame members 94, 95, the degree of freedom in the mounting positions of the upper and lower rear suspension arms 90, 91 in the vertical direction is enhanced without changing the basic structure of the body frame 2.

Also, since the front and rear vertical frame members 94, 95 have U-shaped transverse cross-section, and the mount members 90a, 91a of the upper and lower rear suspension arms

90, 91 are rotatably supported directly by the U-shaped front and rear vertical frame members 94, 95, conventionally used brackets are unnecessary and there is no need to control the welding strength. This is advantageous from the viewpoint of strength and production cost.

In this embodiment, since the front and rear vertical frame members 94, 95 are inclined such that the upper parts of them are located further outside than the lower parts thereof so that the upper rear suspension arms 90 can be shorter in length than the lower rear suspension arms 91, the rolling performance of the vehicle in cornering is improved.

Since the front and rear vertical frame members 94, 95 have a U-shape with the open side facing outside, and since the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are placed within the U-shape of the front and rear vertical frame members 94, 95 and pivoted on the support pins 96, the degree of freedom in the mounting position of the upper and lower rear suspension arms 90, 91 in the vertical direction is enhanced.

Also, all the mount members 90a, 91a of the upper and lower rear suspension arms 90, 91 are rotatably supported by the front and rear vertical frame members 94, 95, the degree of freedom in the mounting position of the rear suspension is further enhanced.

Next, the rear wheel suspension device 14 is described.

The front wheel suspension device 14 of this embodiment has upper and lower front suspension arms 100, 101 disposed on the right and left sides of a front portion of the body frame 2 which suspend the right and left front wheels 3, 3 such that those wheels 3, 3 can independently swing up and down, and shock absorbers (not shown) disposed between the upper front suspension arms 100 and the body frame 2. The outer ends of the upper and lower rear suspension arms 100, 101 are connected by link members 102, and the front wheels 3 are

rotatably supported by the link members 102.

Front and rear suspension frame members 103, 104 which constitute a part of the front frame 21 is joined by welding to the front portion 80a of each of the right and left front frame members (lower frames) 80 of the body frame 2 with a prescribed interval in the longitudinal direction therebetween. The front suspension frame members 103 extend vertically from the front ends of the front frame members 80 and then obliquely upward and backward. The rear suspension frame members 104 extend in parallel to the front suspension frame members 103 and have upper ends joined by welding to the front suspension frame members 103. Each pair of the front and rear suspension frame members 103, 104 are connected by a reinforcement 105 extending in the longitudinal direction, and the right and left rear suspension frame members 104 are connected by a reinforcement 106 extending in the transverse direction.

Each of the front portions 80a of the front frame members 80 has a rectangular transverse cross-section, and has a flat vertical wall 80d on the outside. The front and rear suspension frame members 103, 104 have flat vertical walls 103a, 104a, respectively, on the outside.

Lower brackets 107, 108 with U-shaped transverse cross-section are joined by welding to the outer vertical walls 80d of the front frame members 80 with a prescribed interval in the longitudinal direction therebetween. The front lower brackets 107 are disposed with their open sides facing up, and the rear lower brackets 108 are disposed with their open sides facing down.

U-shaped upper brackets 109, 110 are joined by welding to the outer vertical walls 103a, 104a of the front and rear suspension frame members 103, 104, respectively. The front upper brackets 109 are disposed with their open sides facing outside, and the rear upper brackets 110 are disposed at

positions lower than the front upper brackets 109 with their open sides facing outside. The distance between the upper brackets 109, 110 is smaller than that between the lower brackets 107, 108.

Upper and lower mount members 100a, 101a (pivot parts) are fixed to the front and rear base ends of the upper and lower front suspension arms 100, 101, respectively, with their axes in the longitudinal direction of the vehicle. The upper and lower mount members 100a, 101a are slightly inclined such that the front sides of them are higher than the rear sides thereof.

The upper mount members 100a are pivoted on upper support pins 111 attached to the upper brackets 109, 110. The lower mount members 101a are pivoted on lower support pins 112 attached to the lower brackets 107, 108. The rear lower mount members 101a are located at positions lower than the front lower mount members 101a. The axes connecting the lower mount members 101a and the axes connecting the upper mount members 100a are parallel to each other and slightly inclined upward and forward.

According to the front wheel suspension device 14 of this embodiment, since the outer vertical walls 80d of the front frame members 80 and the outer vertical walls 103a, 104a of the front and rear suspension frame members 103, 104 are flat, and the upper and lower brackets 107 to 110 for supporting the upper and lower front suspension arms 100, 101 are joined by welding to the outer vertical walls 80d, 103a, 104a, the mounting positions of the brackets 107 to 110 can be set freely and the degree of freedom in the swing angle of the front suspension is enhanced without changing the basic structure of the body frame 2.

Also, in this embodiment, since the rear mount members 100a, 101a of the upper and lower front suspension arms 100, 101 are located in positions lower than the front mount members 100a, 101a, respectively, the attitude of the vehicle in

climbing over an obstruction such as a large stone can be stabilized.

Also, since the front frame members 80 have a rectangular transverse cross-section and the front suspension arms 101 are supported on the outer vertical walls 80d of the front frame members 80, the front frame members 80 can be simple in shape and has high frame rigidity.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 is a side view of an all-terrain vehicle to explain an embodiment of the present invention.

[FIG. 2]

FIG. 2 is a top plan view of the all-terrain vehicle.

[FIG. 3]

FIG. 3 is a side view of an engine unit of the all-terrain vehicle.

[FIG. 4]

FIG. 4 is a schematic structural view of the engine unit, as seen in a top plan view.

[FIG. 5]

FIG. 5 is schematic side view of a shift mechanism of the engine unit.

[FIG. 6]

FIG. 6 is a top plan view of the shift mechanism.

[FIG. 7]

FIG. 7 is a perspective view of a body frame of the all-terrain vehicle.

[FIG. 8]

FIG. 8 is a top plan view of the body frame.

[FIG. 9]

FIG. 9 is a perspective view of the body frame.

[FIG. 10]

FIG. 10 is a side view of a front wheel suspension device of the all-terrain vehicle.

[FIG. 11]

FIG. 11 is a cross-sectional front view (cross-section taken along the lone XI-XI in FIG. 10) of the front wheel suspension device.

[FIG. 12]

FIG. 12 is a side view of a rear wheel suspension device of the all-terrain vehicle.

[FIG. 13]

FIG. 13 is a cross-sectional plan view (cross-section taken along the lone XIII-XIII in FIG. 12) of the rear wheel suspension device.

[Description of Reference Numerals]

1 all-terrain vehicle
2 body frame
3 front wheel
14 front wheel suspension device
80 front frame member (lower frame)
80d outer vertical wall
100 upper front suspension arm
100a, 101a upper and lower mount members (pivot parts)
101 lower front suspension arm
107, 108 bracket

[Document Name] Abstract

[Abstract]

[Problem to be Solved] To provide a front wheel suspension device for an all-terrain vehicle in which the degree of freedom in setting the swing angle of a suspension is enhanced without changing the basic structure of the body frame.

[Solution] In a front wheel suspension device for an all-terrain vehicle, a front frame member (lower frame) 80 has flat side walls 80d on the outside in the transverse direction of the vehicle, and the front suspension arms 100, 101 are rotatably supported on the side walls 80d of the lower frame member 80 via brackets 107, 108.

[Selected Drawing] Fig. 10

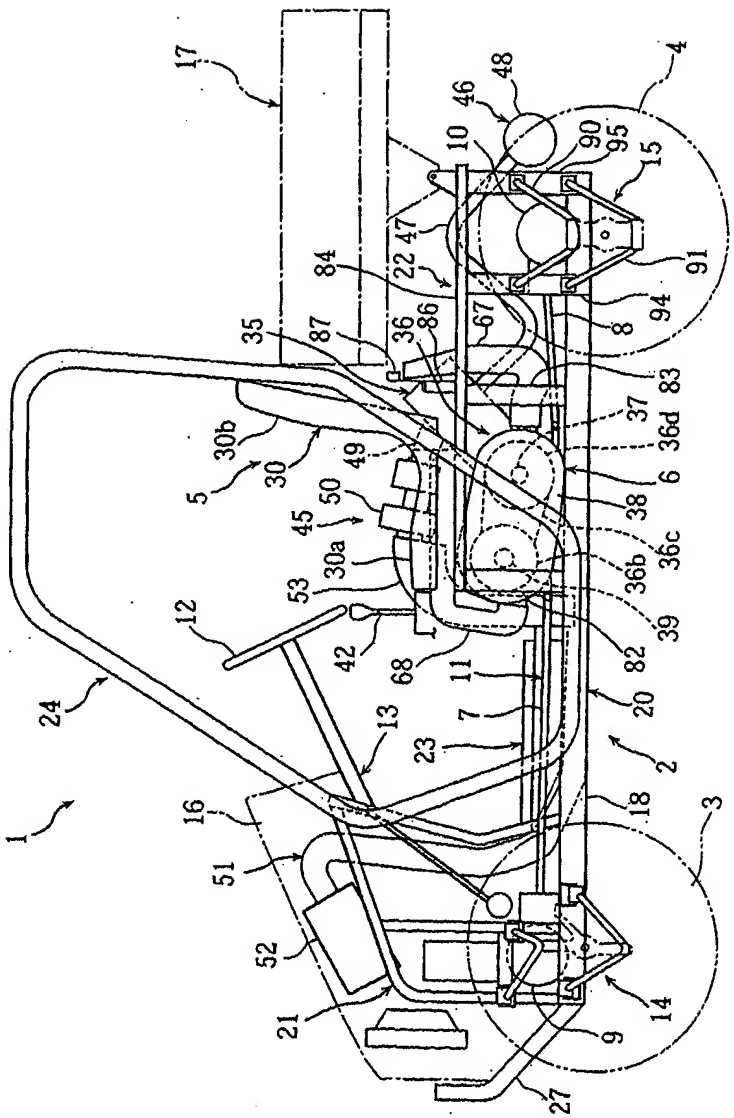
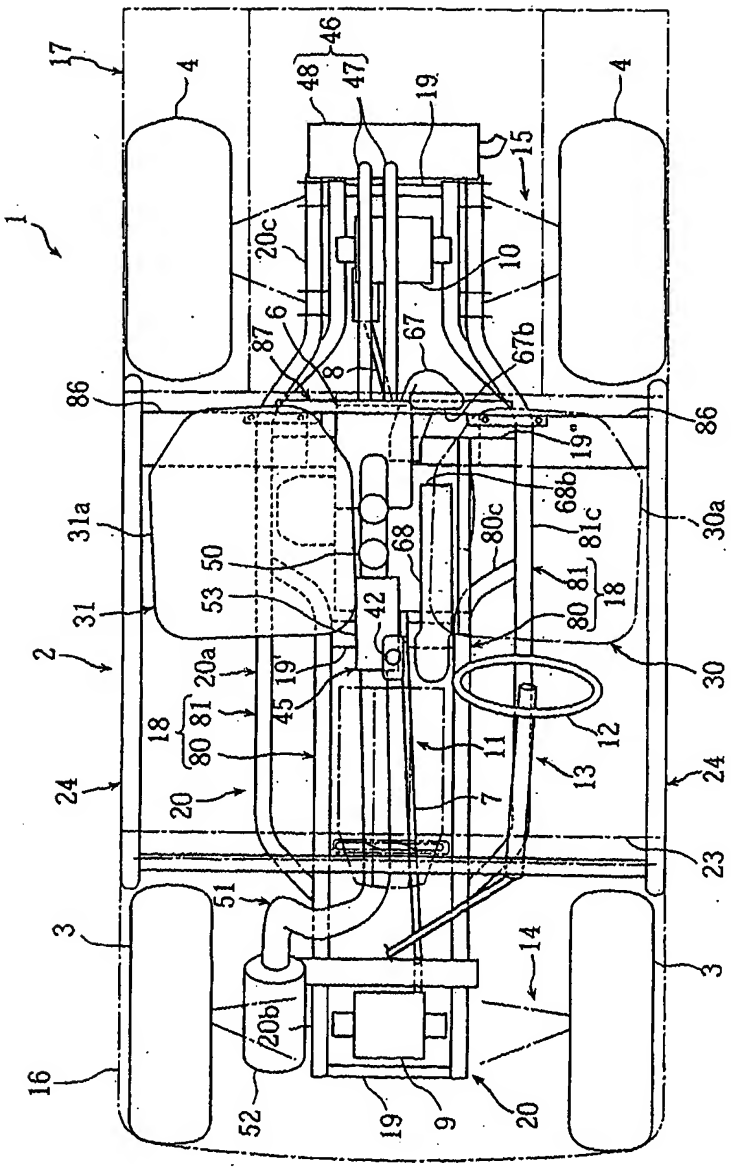


FIG. 1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8
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10
11
12
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14
15
16
17
18
19
19'
19"
20
20a
20b
20c
23
24
30
30a
31
31a
42
45
46
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51
52
53
67
67b
68
68b
80
80c
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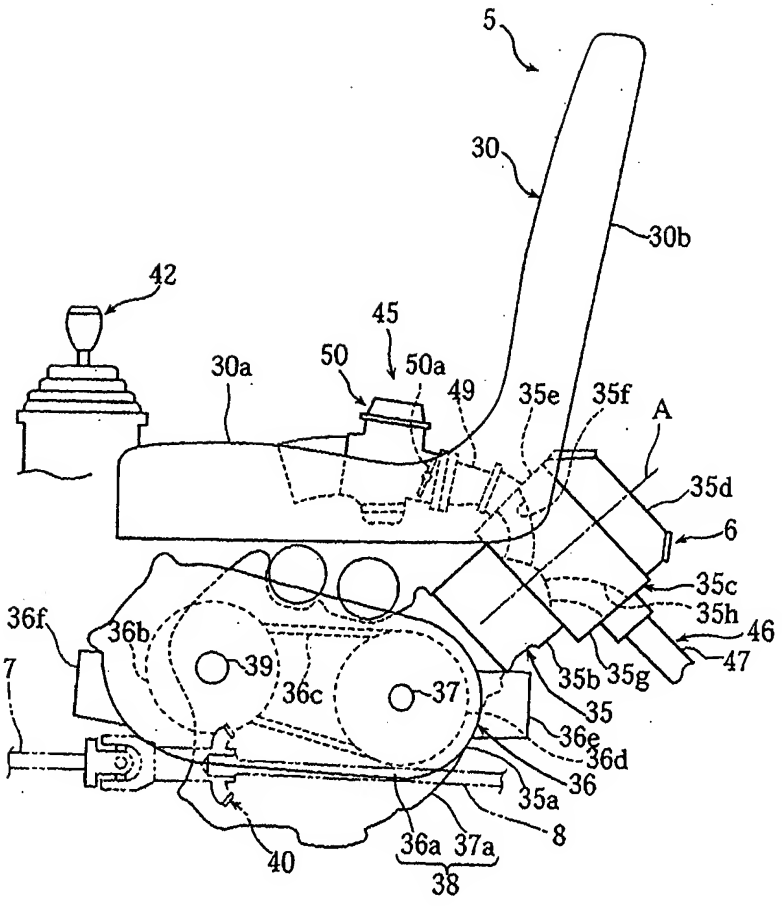
81c
86
87

FIG. 2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50
50a
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35e
35f
A
35d
6
35c
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36b
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36
35a
8
40
36a
37a
38

FIG. 3

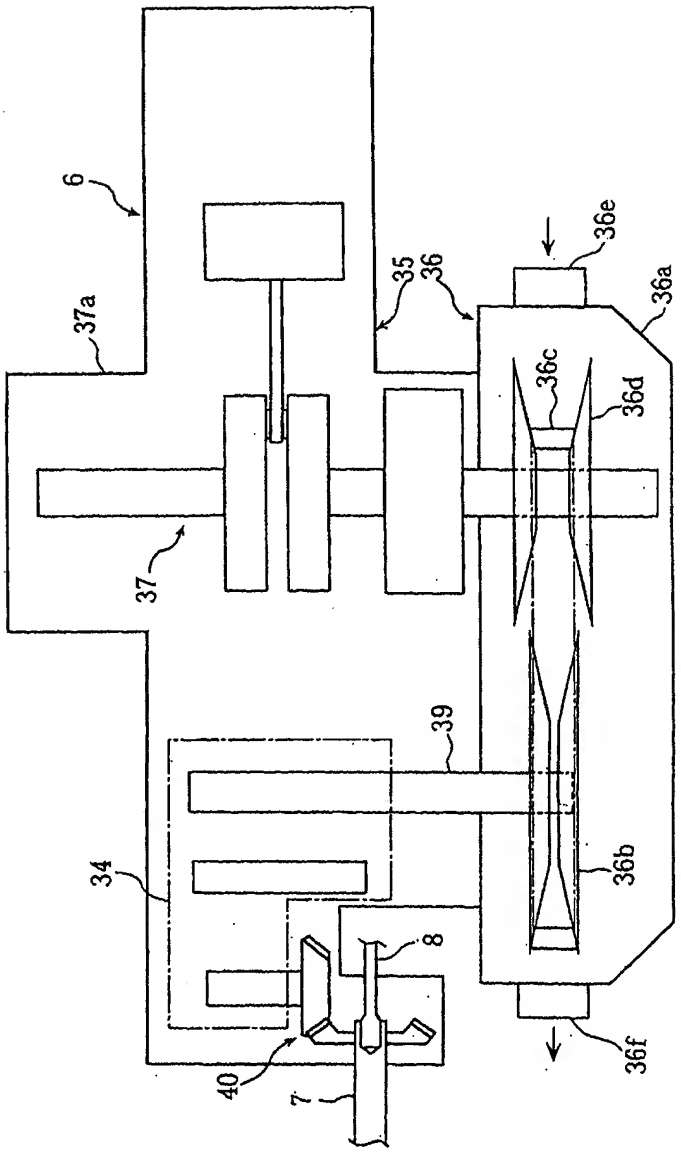


FIG. 4

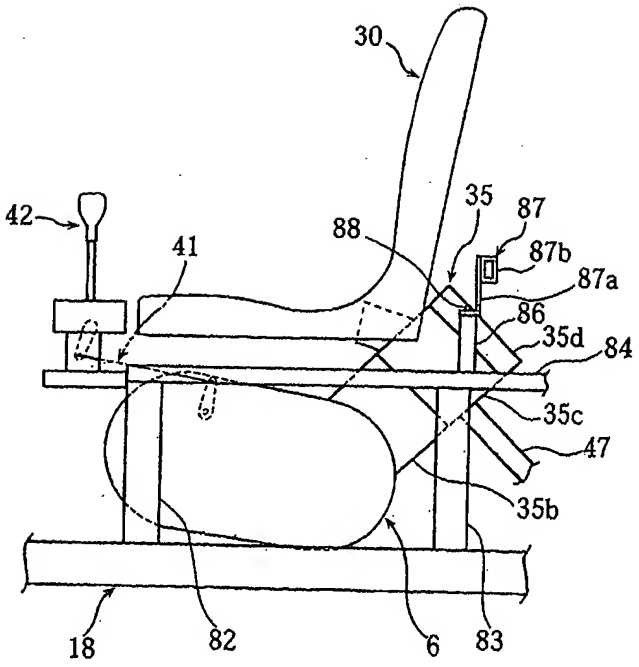


FIG. 5

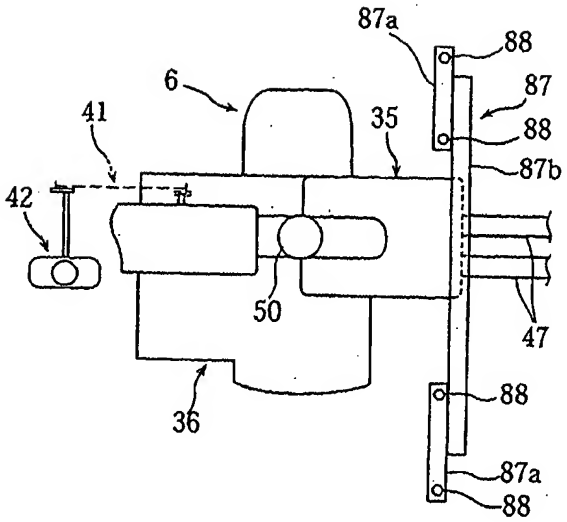
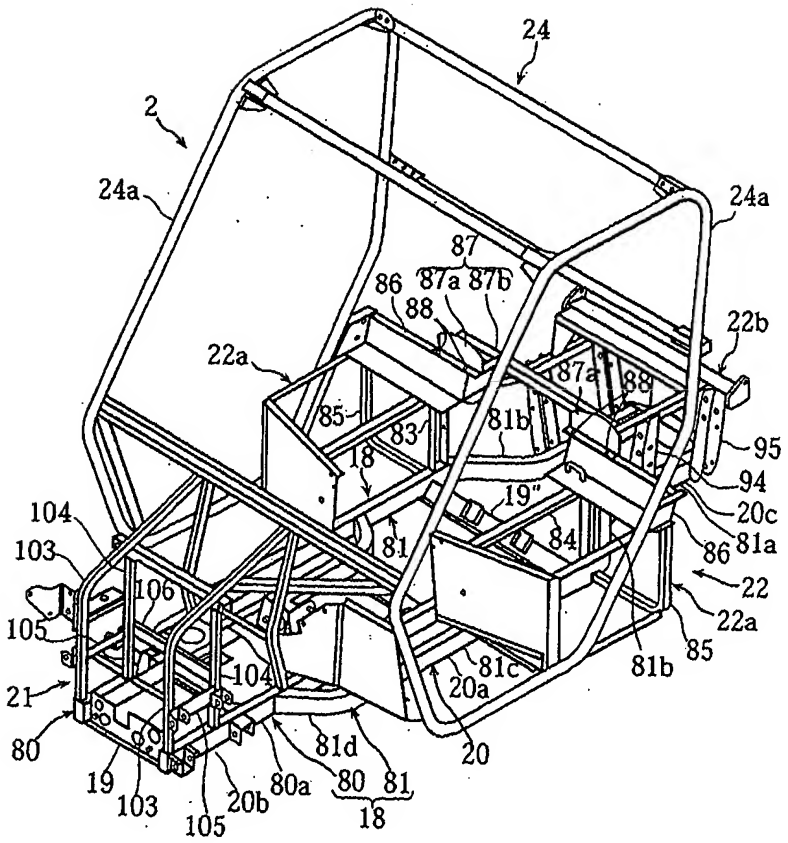


FIG. 6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2
24a
24a
87
86
87a
87b
88
22b
22a
87a
88
85
83
81b
95
18
94
19"
20c
104
103
81
84
86
81a
106
22
105
22a
104
81c
81b
85
21
20a
80
81d
20
19
80a
80
81
103
20b
105
18

FIG. 7

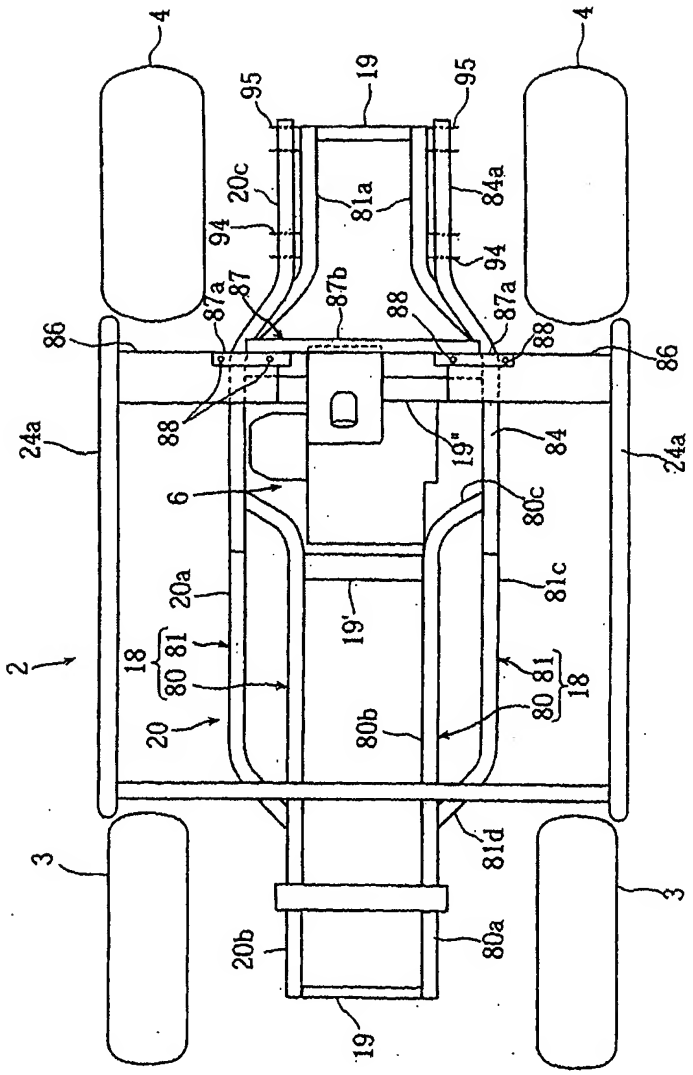

4
95
19
95
4
20c
81a
84a
94
94
87a
87
87b
88
87a
88
86
86
24a
88
19'
84
24a
6
80c
20a
81c
19'
2
18
81
80
20
80b
81
80
18
81d
3
3
20b
80a
19

FIG. 8

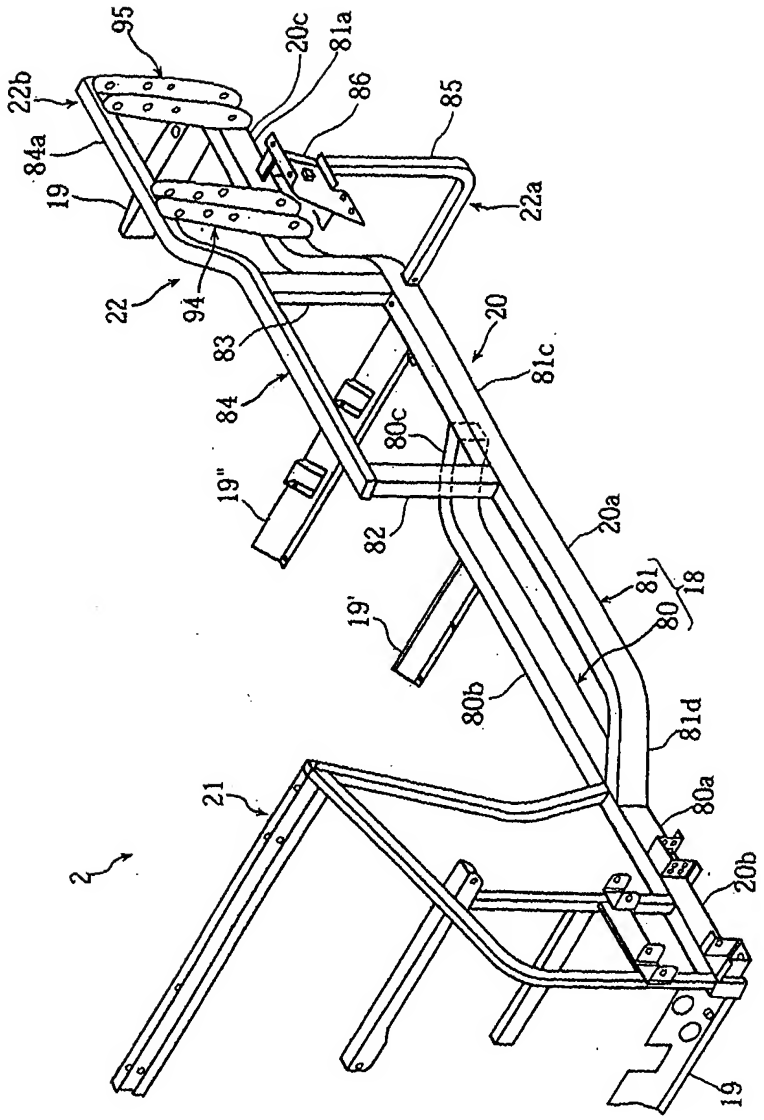
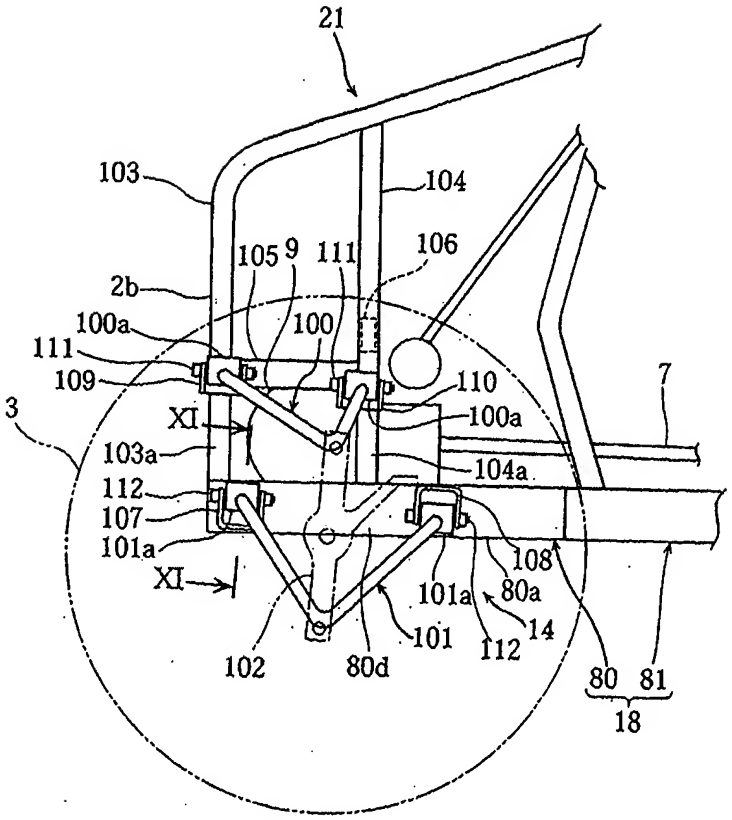

95
20c
81a
22b
86
85
84a
19
22a
22
94
83
20
81c
84
80c
19"
82
20a
81
18
19'
80
80b
81d
21
80a
2
20b
19

FIG. 9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103
104
105
9
111
106
2b
100a
100
111
109
110
7
3
XI
100a
103a
104a
112
107
101a
XI
108
101a
80a
14
101
112
102
80d
80
81
18

FIG. 10

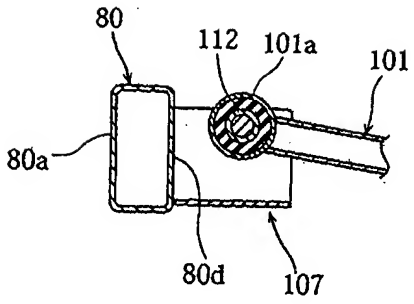
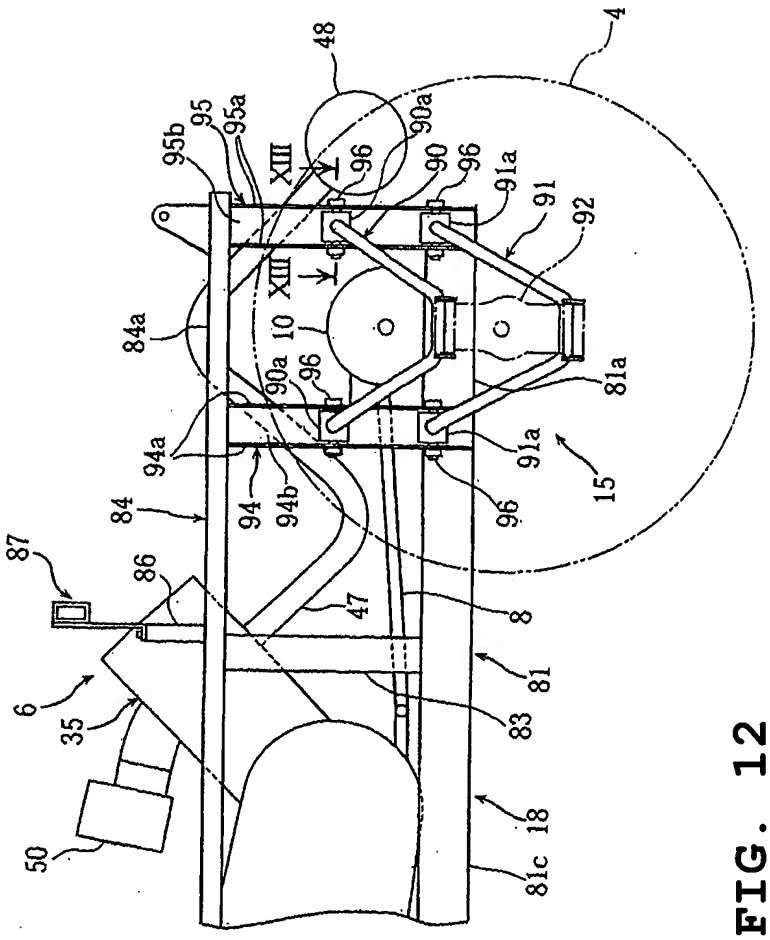


FIG. 11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4
95b
95
95a
90a
XIII
96
90
96
91a
91
92
84a
10
XIII
90a
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81a
94a
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86
47
8
6
35
81
83
50
18
81c

FIG. 12

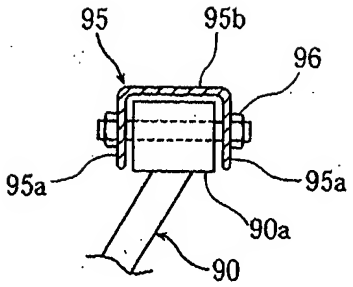

FIG. 13